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I.A. Andryushin, R.I. Ilkaev, A.K. Chernyshev A DECISIVE STEP TO PEACE. Hydrogen bomb with atomic compression RDS-37

To the 55th anniversary of the creation of RDS-37

To the 65th anniversary of RFNC-VNIIEF

INTRODUCTION

The liquidation of the US nuclear monopoly in 1949 as a result of the heroic feat of our people to create the first atomic bomb RDS-1 became the most important step in the struggle for the peaceful life of our people and ending the chain of world wars. However, although this was the most important, it was only the first step. At the end of the 50s, the problem arose of responding to the threat of creating thermonuclear weapons in the United States, the first samples of which were a thousand times more powerful than atomic bombs. It became obvious that without the creation of a similar type of weapon in our country, the threat of nuclear war would be extremely acute, and possibly inevitable. It is in this context that the new outstanding achievement of KB-11 and the entire nuclear industry in the field of national defense should be considered - the creation of the RDS-37 thermonuclear charge based on the new physical principle of radiation implosion.

This principle was formed in the process of intensive work in other areas of hydrogen weapon design, which had previously been given priority. Fundamental to the creation of the RDS-37 was the experience of developing the RDS-6s, a “puff” atomic bomb with thermonuclear enhancement, tested in 1953.

The development of the RDS-37 took only a year and a half. Its organizers - outstanding scientists of our country - managed to provide an extraordinary creative environment in which

a new generation of scientists was growing up, who came to KB-11 in the mid-50s and 60s and made a decisive contribution to the practical achievement of nuclear parity. The leaders of the Ministry of Medium Engineering, the Ministry of Defense, leading scientists, thousands of specialists and military personnel took part in the preparation and testing of the RDS-37 at the Semipalatinsk test site and ensuring its safety. The role of KB-11 in the development and creation of the RDS-37 was decisive.

The creation of the RDS-37 thermonuclear bomb, based on the practical implementation of new profound scientific ideas, is the result of concentration of efforts at all technological levels, primarily intellectual,

which formed the basis of our country's thermonuclear arsenal, which subsequently ensured nuclear deterrence and national security. The creation of thermonuclear weapons was a turning point in the military confrontation of the 20th century and made the third world war impossible.

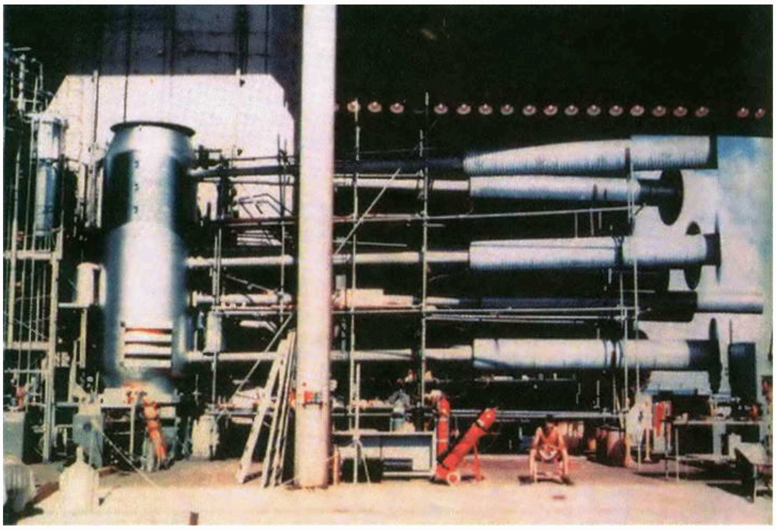
1. CRITICAL SITUATION - THE THREAT OF THE US THERMONUCLEAR MONOPOLY

The creation and testing of the first atomic bomb RDS-1 in the USSR on August 28, 1949 undoubtedly told the whole world about the significant scientific and technical potential and large material resources of our country. For a long time, US President G. Truman could not believe that “these Asians could make such a complex weapon as an atomic bomb,” and only on September 23, 1949, he officially announced that the USSR had tested an atomic bomb.

On January 31, 1950, G. Truman announced his decision to begin a full-scale program to develop a superbomb (hydrogen bomb). In 1952, the United States tested a prototype of a powerful hydrogen bomb (the “Mike” experiment) with an energy release of 10.4 Mt, and in 1954 it successfully implemented a testing program for new thermonuclear charges, which became the basis of US strategic nuclear forces in the mid-50s . At the same time, their mass production was organized on a huge scale. So, for example, for 18 months 1955-1957. 1,200 MK-15 thermonuclear warheads (air bombs) with an energy release of 1.7 Mt each were produced. The serial production rate of megaton bombs was about 55 warheads per month, or 2 warheads per day.

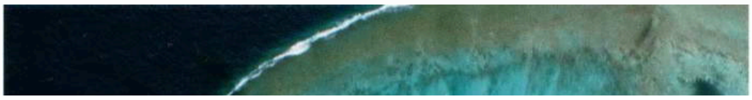
In the 50s, US strategic aviation had 1,850 B-52 and B-47 bombers, intended to deliver nuclear and thermonuclear ammunition. They were based at 65 air bases, including 25 airfields in other countries.

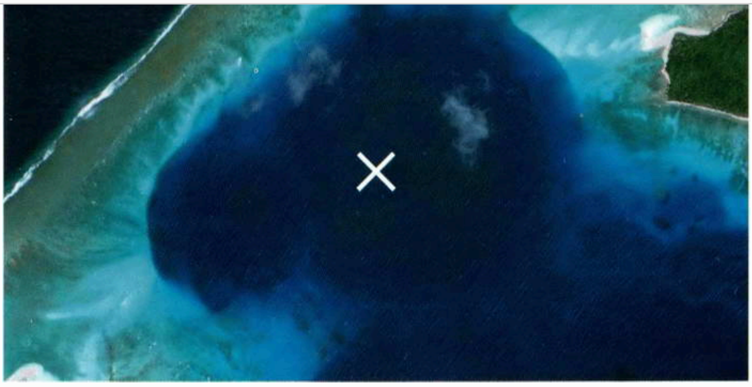
On January 25, 1950, the Korean War began with the participation of the United States, UN forces and the People's Republic of China, which lasted until the end of July 1953. For the Korean War, the United States attracted 35% of regular air force aircraft, and strategic aviation was also used. However, they failed to achieve a significant advantage. The US coalition lost 3 thousand aircraft. The US discussed the possibility of using nuclear weapons during this war, and its results directly influenced the buildup of US nuclear weapons of various types.



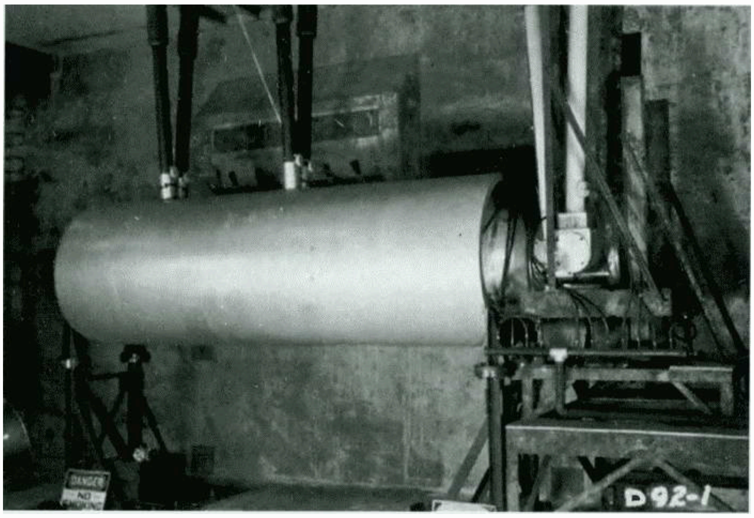
"Mike" charge with radiation output channels for measurements. The bomb itself is located vertically on the left, behind it in the background is cryogenic equipment for maintaining deuterium and tritium in a liquid state, around are cylinders with liquid helium

Ground explosion "Mike", rising explosion cloud to a height of 36 km





Crater from the Bravo explosion on Bikini Atoll



Thermonuclear charge for testing "Bravo" with a power of 15 Mt, weighing ~ 12 t

In 1952, the United States introduced tactical nuclear weapons into Europe, radically influencing the nature of possible ground operations on the continent.

One of the important characteristics of the intensity of work to improve nuclear weapons can be the dynamics of ongoing nuclear tests.

Динамика ядерных испытаний США и СССР в 50-е годы

Общее число испытаний	Годы						
	1952	1953	1954	1955	1956	1957	1958
США	34	45	51	69	87	119	196
СССР	3	8	18	24	33	49	83
δ	0,088	0,18	0,35	0,35	0,38	0,41	0,42

*The table shows the "cumulative" values of the number of nuclear tests, that is, the total number of tests for the indicated and all previous years; **δ** is the ratio of the number of nuclear tests of the USSR to the number of nuclear tests of the USA. A moratorium on nuclear testing began in 1958 and lasted until 1961.*

It should be noted that after a period of initial growth, the number of nuclear tests of the USSR, until their resumption in 1961, was 2.5-3 times less than the number of US nuclear tests at each current point in time. This meant a serious scientific and technical lag.

The most important characteristic of nuclear confrontation is the size of nuclear arsenals.

Динамика роста ядерных арсеналов США и СССР в 50-е годы

Число ЯБП	Годы							
	1953	1954	1955	1956	1957	1958	1959	1960
США	1169	1703	2422	3692	5543	7345	12298	18638
СССР	~120	~150	~200	~420	~660	~870	~1060	~1600
δ	0,1	0,088	0,083	0,113	0,12	0,114	0,086	0,086

δ is the ratio of the number of nuclear warheads in the USSR to the number of nuclear warheads in the USA.

These data show a huge gap in the volume of the US nuclear arsenal from the USSR, which was -10 times. Even more important was that since 1956, thanks to the powerful thermonuclear charges created in 1954 and later, the US nuclear arsenal acquired the quality of "total destruction." The total megatonnage of US nuclear weapons by 1956 reached ~ 9 thousand megatons[1] . The USSR had nothing like this at that time. This circumstance emphasizes the truly historical significance of the events, the creation and successful testing of the RDS-37 on

Castle Series, Bravo Challenge (FH Shelton)

The Cherokee Redwing explosion mushroom at Bikini Atoll rose above the clouds. This photo was taken from an airplane at 10,000 feet about 50 miles southwest of ground zero.

In the USA, the technical specifications for the development of thermonuclear charges TX-17 and TX-24 with LiD of natural composition and low enrichment were issued on February 24, 1953.

Five tests in 1954 of powerful two-stage thermonuclear charges based on "solid" thermonuclear fuel with lithium deuteride of varying degrees of enrichment laid the foundation for the US thermonuclear program. The results of development and testing were immediately transferred to mass production and implemented for use by US strategic aviation. Obviously, there was no complete confidence in the success of field tests with charges based on lithium deuteride, and in 1953, serial production of the TX-16 thermonuclear charge with liquid deuterium, which was also intended for delivery by strategic aviation, was organized in the United States. From January to April 1954, 5 such thermonuclear munitions were produced. Since the 1954 test results were successful, the need for a hydrogen bomb with liquid deuterium was no longer necessary.

Этапы программы испытаний термоядерных зарядов США в первой половине 50-х годов XX века

Дата испытания*	Кодовое название	Мощность взрыва	Место проведения	Условия подрыва заряда	Примечания
09.05.51.	Georg	225 кт	Эниветок	башня	Первое термоядерное устройство, схема Фукса–Неймана
25.05.51	Item	45,5 кт	Эниветок	башня	Первое испытание ядерного заряда с термоядерным усилением
01.11.52	Mike	10,4 Мт	Эниветок	поверхность	Первый двухступенчатый термоядерный заряд по схеме Теллера–Улама с использованием жидкого дейтерия
01.03.54	Bravo	15 Мт	Бикини	поверхность	
27.03.54	Romeo	11 Мт	Бикини	баржа	
26.04.54	Union	6,9 Мт	Бикини	баржа	
05.05.54	Yankee	13,5 Мт	Бикини	баржа	
14.05.54	Nectar	1,69 Мт	Эниветок	баржа	
21.05.56	Cherokee	3,8 Мт	Бикини	самолет	Первое испытание термоядерной бомбы сбросом с самолета

*** Test dates are given in Greenwich Time.**

Внедрение результатов разработок и испытаний 1954 г. термоядерных зарядов США в систему вооружений

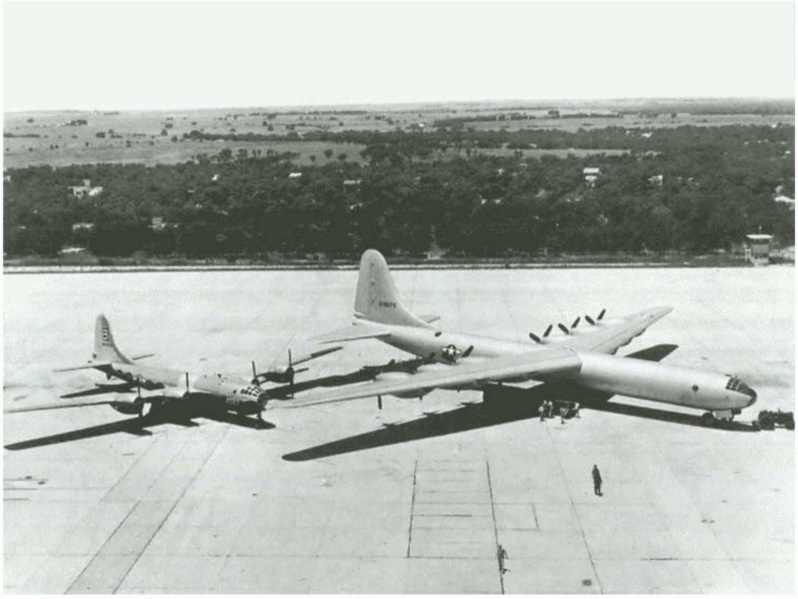
Термоядерный боеприпас	Испытание	Термоядерное горючее	Мощность, Мт	Количество ЯБП	Сроки производства	Общий мегатоннаж, Мт	Масса ЯБП, т	Примечание
TX-14	Union	95% Li^6D	5–7	5	февраль–октябрь 1954 г.	30	~13,6	Первый развернутый термоядерный заряд
EC-17	Romeo	природный LiD	11	5	апрель–октябрь 1954 г.	55	~ 18	Развернутый прототип MK-17
MK-17	- " -	- " -	10–15	200	июль 1954 г. – ноябрь 1955 г.	2500	~18,9	Снят с вооружения в 1957 г.
EC-24	Yankee	обогащенный LiD	13,5	5	апрель–октябрь 1954 г.	67,5	~18	Развернутый прототип MK-24
MK-24	- " -	- " -	10–15	105	июль 1954 г. – ноябрь 1955 г.	1300	~18,9	Снят с вооружения в в октябре 1956 г.
MK-15	Nectar	- " -	1,69	1200	апрель 1955 – февраль 1957 г.	2000	~3,45	Снят с вооружения в 1961 – 1965 гг.

The table clearly shows the speed of putting thermonuclear charges into service and replacing them within a few months, after testing, with more successful designs.

Developments based directly on the results of four 1954 tests of the "Castle" series were transferred to service as part of 4 types of nuclear warheads. The total number of thermonuclear ammunition of these types transferred into service was ~1500 units with a total energy release of 6000 megatons. The results of the 1954 tests created a gigantic first thermonuclear strike potential for the United States.

According to the Strategic Air Command's 1954 Master War Plan, the goal was to "destroy the nation," that is, the Soviet Union. The United States envisaged a pre-emptive strike on 1,700 targets and 409 airfields with 750 bombers using 750 atomic bombs. According to the chairman of the KNS, General Lemay, the third world war should have lasted no more than 30 days, leaving only "smoking radioactive ruins" from Russia.

In 1954, the USSR allocated air defense as an independent branch of the military, and around Moscow began to deploy a ring of S-25 Berkut surface-to-air missiles (SA-1 Guild according to NATO classification), capable of carrying atomic weapons.



The B-36 intercontinental bomber (right) - the carrier of the MK-17 thermonuclear bomb, the largest combat aircraft in the history of aviation - in comparison with the B-29 (left), which dropped bombs on Hiroshima and Nagasaki

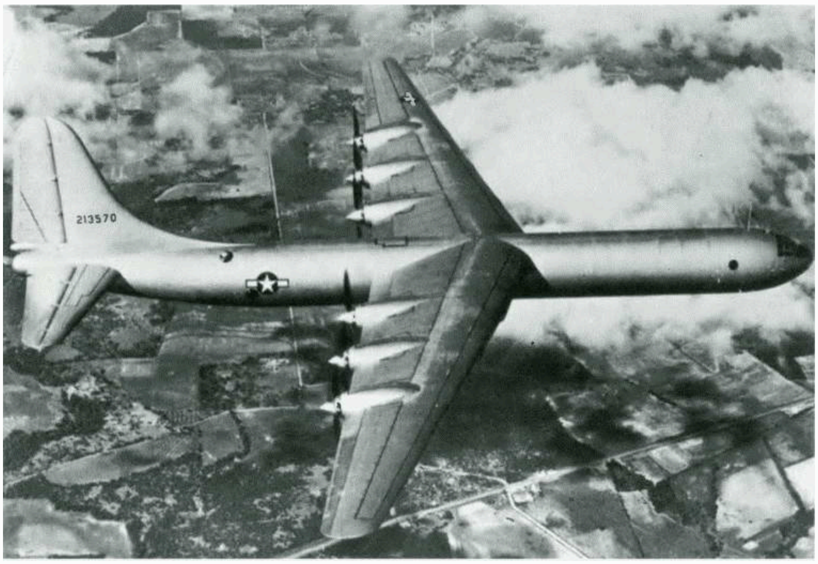
2. PROBLEMS OF DELIVERY MEANS OF THERMONUCLEAR WEAPONS

In the mid-50s, the nuclear capabilities of the USSR and the USA were incommensurable. It's not just the number and megatonnage of nuclear weapons, but also the capabilities of the delivery vehicles. In the United States, already in 1948, the B-36 strategic bomber entered service, and in 1955, the B-52 strategic bomber, which were equipped with nuclear and thermonuclear weapons. In addition, numerous US military bases were located along the perimeter of the USSR borders, which could be (and were) used to host various types of aircraft with a shorter range, also equipped with nuclear weapons. This entire US nuclear weapons system threatened facilities located directly on the territory of the USSR, and the Soviet Union at that time did not have reliable means of delivering nuclear weapons to US territory, and could only carry out a “deterrent threat” against American troops abroad and their allies (mainly in Europe). It is clear that in such conditions, the tasks of not only improving nuclear and thermonuclear ammunition, but also creating means of their delivery with an intercontinental range were extremely important. To solve these problems, three programs were aimed at creating:

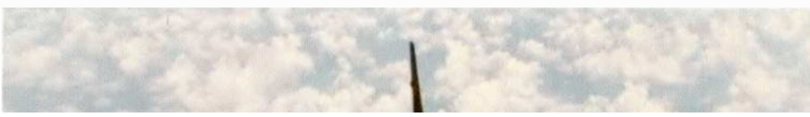
strategic bomber;

intercontinental ballistic missile (ICBM);

nuclear ballistic missile submarine (SLBM).



Intercontinental bomber B-36. Combat load 38 tons (2 MK-17 bombs, 19 tons each); range 7000 km. Years of production: 1948-1954, by 1954 the US had 342 B-36s in service



B-52 strategic bomber. Combat load 22.6 tons, carrier MK-5, 6, 15, 17, 36, 39; range 16,000 km. In US service since 1955, 744 B-52s were built from 1952 to 1962

STRATEGIC AVIATION

The decree of the Soviet Government of March 24, 1951 ordered the creation of a design bureau under the leadership of V.M. Myasishchev to develop a strategic jet bomber capable of delivering nuclear weapons to the United States. The aircraft's range was supposed to be 11,000-12,000 km with a bomb load of 5 tons. The M-4 aircraft was built in record time and began flight testing on January 20, 1953. However, its range was only 8500 km, which was not enough to solve the task. The aircraft was modernized, and its new variant, the ZM, with a range of about 12,000 km, made its first flight on March 27, 1956. The M-4 aircraft entered service in 1956, and the 3M aircraft in 1958.

Jet strategic bomber ZM. Combat load 5 tons, range 12,000 km. In service with the USSR since 1958.

On July 11, 1951, the Government decree ordered the start of the design bureau under the leadership of A.N. Tupolev's work on creating a strategic bomber. On November 12, 1952, the Tu-95 aircraft made its first flight. Its range was about 13,000 km. In August 1957 it was put into service.

Solving the problems of creating the 3M and Tu-95 aircraft marked the beginning of the development of strategic aviation in the USSR, and historically, these strategic bombers were the first type of weapons capable of hitting targets in the United States.

It should be noted that the number of strategic bombers of the USSR in the 50s was small.

The Tu-16A carrier aircraft for free-falling atomic bombs is the first Soviet mass-produced aircraft for delivering nuclear weapons. Produced since 1954. A total of 453 vehicles of this modification were built until 1958

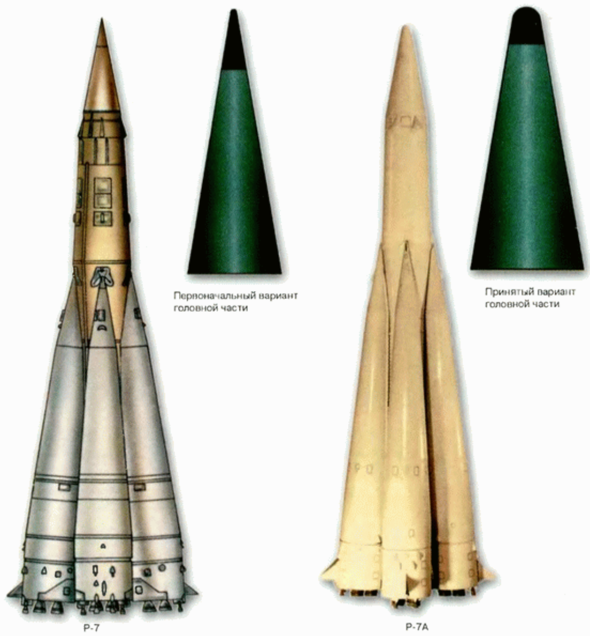
Turboprop strategic bomber Tu-95. Bomb load 5-15 tons depending on flight range

In 1956 there were about 20 of them. Even in 1960 there were about 140 of them (of which Tu-95 - about 60%). The potential of the USSR strategic aviation was much less than the potential of the US strategic aviation, the base location was significantly further from the territory of a potential enemy, and the United States by that time had a developed air defense system. These circumstances determined the subsequent secondary role of strategic aviation in the strategic nuclear forces of our country.

INTERCONTINENTAL BALLISTIC MISSILES

The start of work on the creation of the R-7 ICBM dates back to 1953 and was confirmed by a Government Decree of May 20, 1954. The R-7 missile was a two-stage liquid fuel rocket (kerosene and liquid oxygen) weighing 280 tons with a throw weight of 5.4 t and a range of 8000 km. The missile was located at a ground launch complex. Its developer was OKB-1, and its chief designer was S.P. Korolev. Flight tests of the R-7 were carried out from 1957 to 1959, and on January 20, 1960, this first Soviet ICBM was put into service.

The range of the R-7 ICBM was insufficient, so already in 1958 a decision was made to create an improved version of it - the R-7A ICBM - with lighter combat equipment (throwing weight 3 tons) and a range of up to 12,000 km. This version of the ICBM was put into service on September 12, 1960. Thus, the fundamental task of creating the necessary means of delivering nuclear weapons in the form of ICBMs was solved. There was a long road ahead for the development of this type of weapon.



Modifications of the first Soviet ICBM

For comparison, let us present some data on the beginning of the development of US ICBMs.

Characteristics of the R-7 missile...... Operational combat index of the missile (R-7 / R-7A

Maximum range, km...... 276 / 276

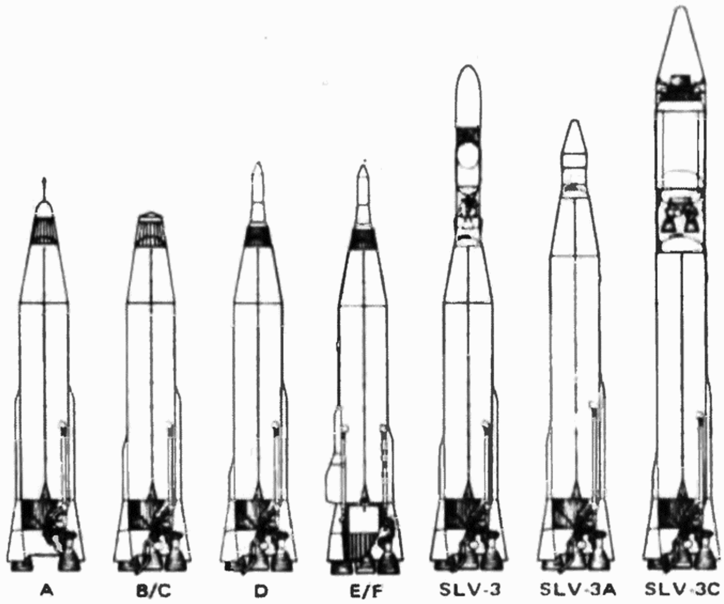
Launch weight, t...... ~120 / ~150

Payload weight, kg...... 5400 / 3700

Head type...... monoblock, nuclear / monoblock, nuclear

Power, Mt...... 3 / 3

Firing accuracy, km 10 / 10



Launch of the Atlas rocket and its modifications (below). Atlas-D ICBM: launch weight 119 tons, maximum firing range 16,000 km, W-49 warhead with a capacity of 1.45 Mt, fuel - kerosene, oxidizer - liquid oxygen

The initiator of the ballistic missile program in the United States during World War II was Theodor von Karman. At the turn of the 1950s. The United States already had various programs to create nuclear-armed surface-to-ground, surface-to-air, air-to-ground, and air-to-air missiles. At the same time, however, a number of difficulties emerged related to the large weight and size parameters of US nuclear weapons at that time. In October 1953, the Ad Hoc Committee on Strategic Missile Development, led by the eminent mathematician John von Neumann, reviewed various missile programs and determined that strategic ballistic missiles could be rapidly developed and deployed if the necessary resources were allocated.

On July 1, 1954, the decision was made to develop the first US Atlas ICBM, and production of these missiles began in June 1957. The first Atlas missiles were deployed in the United States in September 1959.

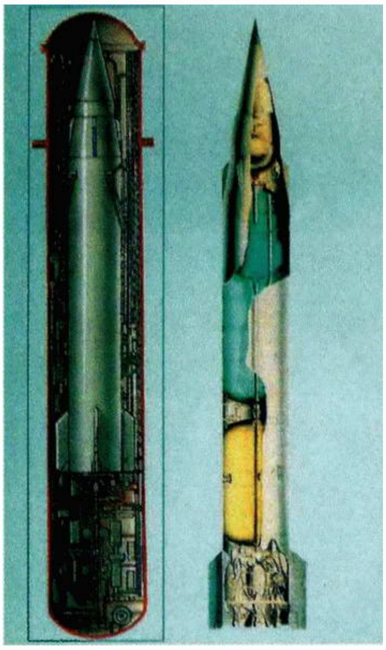
The Atlas rocket had a length of 26 m, a diameter of 4.9 m and cryogenic fuel. The large size of the rocket was determined by the fact that, according to the original plan, it was supposed to deliver very heavy thermonuclear warheads (based on Mike-type charges) over intercontinental distances. In connection with progress in the creation of thermonuclear weapons in 1954 (Castle tests), the design of the Atlas rocket was revised, and the rocket became significantly smaller. The first successful test of Atlas took place in December 1957, and in 1958 the required ICBM range of 10,200 km was achieved. Subsequently, three types of Atlas missiles were deployed, differing in the types of launchers.

"Atlas-D" was placed on an unprotected platform on the surface of the earth in a horizontal position and transferred to a vertical position for refueling and launches. The Atlas-E variant was placed horizontally in an underground bunker, in which the launcher was protected by a heavy reinforced cover. Before refueling and launching, the lid was opened and the ICBM was moved to a vertical position. The Atlas-F variant was placed vertically in a silo launcher. Before launch, the lid was opened and the ICBM rose to the surface. The Atlas-E ICBM was deployed in the period 1959-1961, and the Atlas-F ICBM in 1960-1962. Atlas-E and Atlas-F were equipped with W-38 warheads with an energy release of 3.75 Mt. Atlas missiles were in service until 1965, with a total of 129 launchers of these missiles deployed.

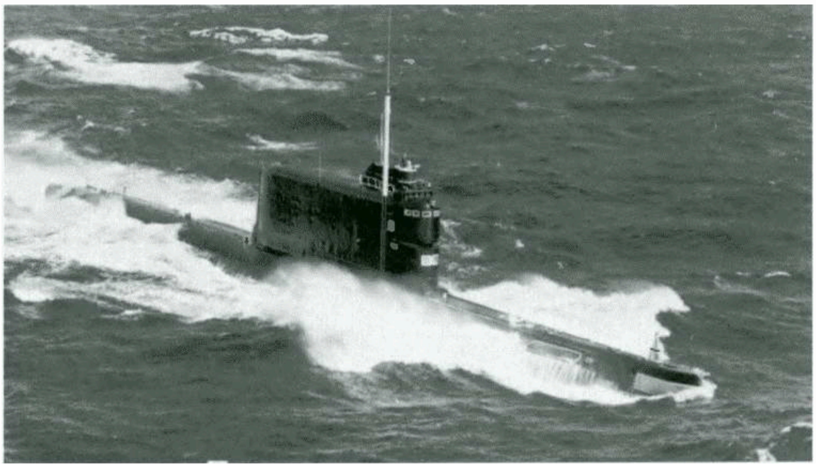
SUBMARINE BALLISTIC MISSILES

The first Soviet SLBMs with a charge developed by KB-11 were placed on diesel submarines. The D-1 complex with R-11FM missiles was initially deployed on diesel submarines of the B-611 and AV-611 projects. Each submarine of this type carried two SLBMs. To launch missiles, the submarine had to surface. The work on the creation of this submarine was determined by the Government Decree of January 26, 1956.

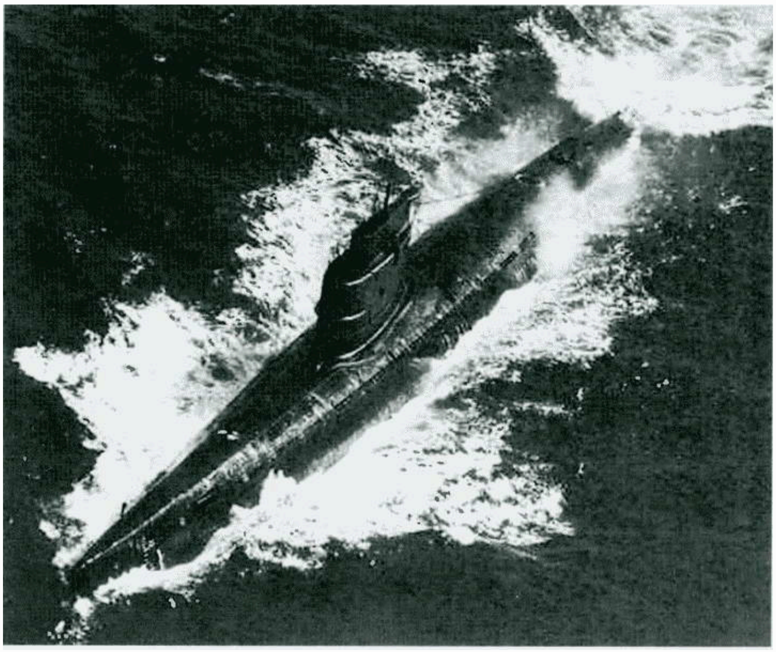
The D-2 complex with R-13 missiles was initially deployed on diesel submarines of Project 629 - the first special missile submarines of the USSR. Project 629 was created by TsKB-16 according to the Decree of the USSR Government of January 26, 1954. Each submarine carried three SLBMs. The missiles were launched on the surface. At the end of 1958, Project 629 submarines were tested, and in 1960 they entered service with the Navy. Due to the insufficient range of the R-13 missiles, in March 1958 a decision was made to convert the submarine to the D-4 complex - Project 629A. Project 629 submarines were in operation from 1959 until the end of the 70s, and Project 629A submarines from 1967 to 1990.



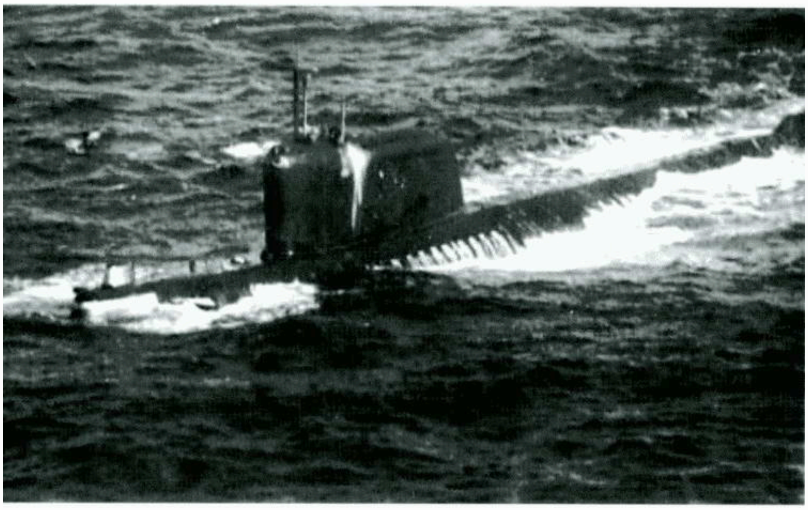
Missile system D-2 with SLBM R-13



Project 629 diesel missile submarine



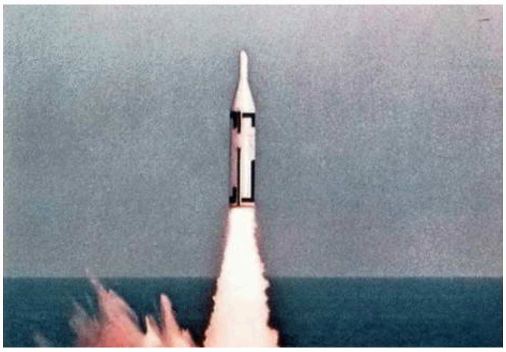
Project 611 large diesel-electric submarine



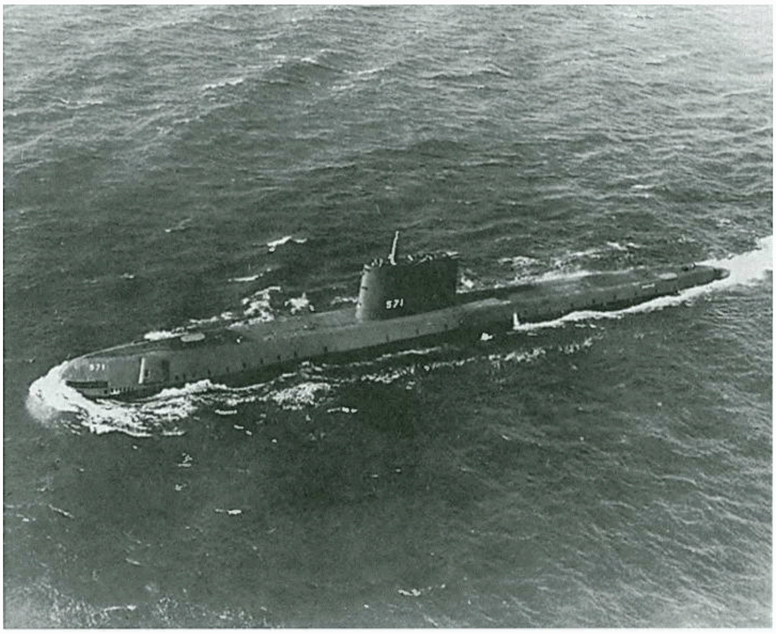
Project 658 nuclear submarine

The decision to build the first nuclear submarines with ballistic missiles was made on August 26, 1956. The first nuclear submarine (K-19) of Project 658 was laid down on October 17, 1958 and built on November 12, 1960. This nuclear submarine was developed at TsKB-18 under the leadership of the chief designer S.N. Kovaleva. The combat equipment of the first nuclear submarines was the R-13 ballistic missile (D-2 complex) developed by SKB-385 under the leadership of chief designer V.P. Makeeva. The start of development was determined by the Government Decree of August 25, 1955; its task was to significantly increase the range of SLBMs, compared to the R-11FM, in order to destroy targets deep in enemy territory. The R-13 was a single-stage rocket with a monoblock detachable warhead, liquid fuel, a mass of 13.7 tons, a throw weight of 1.6 tons and a range of 600 km. On October 13, 1961, the D-2 complex was put into service, thereby solving the third task of creating strategic means of delivering nuclear weapons to the USSR.

For comparison, let us present data on the initial stage of the creation of nuclear submarines with ballistic missiles in the United States.



Two-stage SLBM "Polaris-A 1" with a monoblock warhead separating in flight, equipped with a W-47 thermonuclear device with a power of 600 kt; weight 15.9 t, diameter 137 cm, length 984 cm, flight range 2220 km, maximum flight speed 12000 km/h



The first US nuclear attack submarine SS-571 Nautilus

Research into the possibility of creating nuclear submarines began in the United States in 1946 under the leadership of Hyman Rickover. In 1947, a special KAPL laboratory was created for the design, testing and construction of naval nuclear reactors. The first nuclear attack submarine Nautilus entered service in January 1955. The decision to create a ballistic missile system based on nuclear submarines was made in August 1955, and in November 1960 the first nuclear submarine George Washington "with the Polaris SLBM went on combat duty. It should be noted that it was initially planned to use the Jupiter medium-range ballistic missile to equip the nuclear submarine, but its weight and dimensions (weight 73.6 tons) and the use of liquid fuel in it caused great difficulties. This led to the development in March 1956 of the Navy's requirements for the development of a light (13.6 ton) solid-fuel rocket equipped with light thermonuclear warheads. These requirements formed the basis of the Polaris project.

Nuclear-powered missile submarine SSBN-598 George Washington.

Launch date: June 1959.

Crew - 112 people.

Dimensions - 116.3 x 10 x 8.8 m.

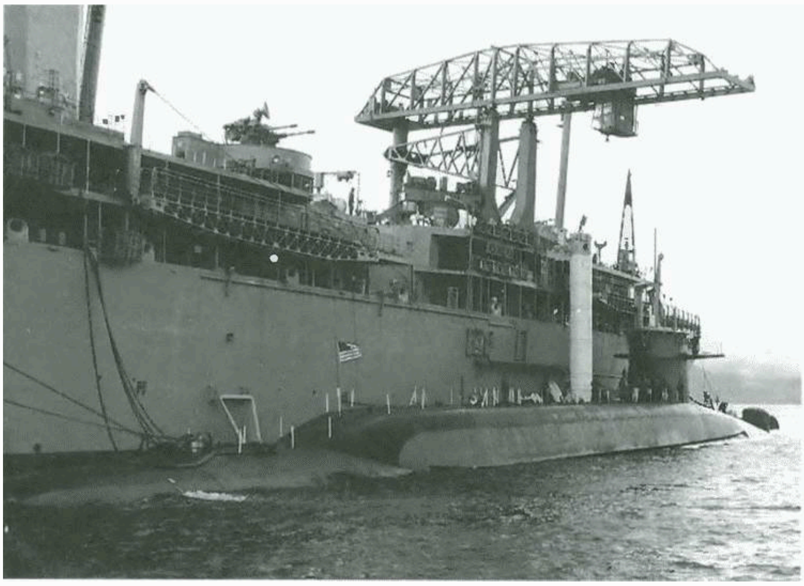
Armament: 16 Polaris missiles, six 533-mm torpedo tubes.

The power plant is a water-cooled nuclear reactor and steam turbines with a capacity of 15,000 hp. With.

The surface cruising range is not limited.

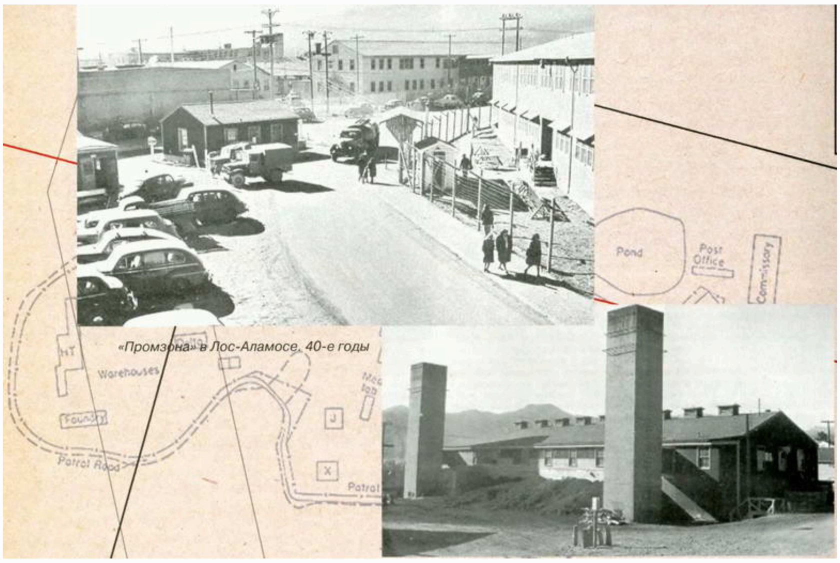
Surface speed is 20 knots, submerged speed is 30.5 knots.

Missile launches could be carried out from a depth of no more than 25 m at a speed of no more than five knots, and only sequentially



Loading a container with a missile into a George Washington class submarine

Thus, although the United States was significantly ahead of the USSR in terms of time in the development of strategic aviation, the time frame for putting ICBMs and SLBMs into service in the two countries was close. At the same time, the technical characteristics of nuclear submarines with US ballistic missiles were significantly higher.



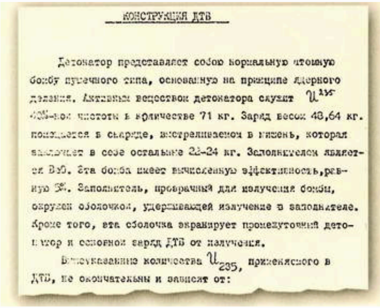
3. FIRST STAGES OF THE US THERMONUCLEAR PROGRAM

DEUTERIUM SUPER BOMB

The beginning of thermonuclear research in the United States dates back to the summer of 1942, when in Berkeley, while discussing plans for the Los Alamos Laboratory, E. Teller presented the first reports that became the basis for the “Classic Super” deuterium superbomb project /1/.

The ideas for creating this hydrogen bomb were based on the following assumptions:

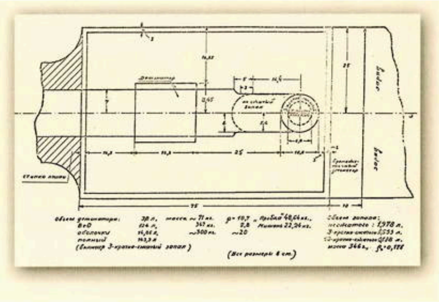
in a cylinder with liquid deuterium, a regime of stable thermonuclear detonation is possible in the absence of thermodynamic equilibrium of radiation with matter;



КОНСТРУКЦИЯ ДТВ

Детонатор представляет собою нормальную атомную бомбу пушечного типа, основанную на принципе ядерного деления. Активным веществом детонатора служит U^{235} 40%-ной чистоты в количестве 71 кг. Заряд весом 48,64 кг. помещается в снаряде, выстреливаемом в мишень, которая включает в себя остальные 22-24 кг. Заполнителем является BeO. Эта бомба имеет вычисленную эффективность, равную 5%. Заполнитель, прозрачный для излучения бомбы, окружен оболочкой, удерживающей излучение в заполнителе. Кроме того, эта оболочка экранирует промежуточный детонатор и основной заряд ДТВ от излучения.

Вышеуказанные количества U_{235}, применяемого в ДТВ, не окончательны и зависят от:



Intelligence analysis materials on the principle of radiation implosion (40% purity - probably a typo) and a schematic drawing of a two-stage Fuchs-von Neumann hydrogen bomb (declassified by the SVR in 1992, and published in VIET).

Work on this project continued essentially until 1950, when the impossibility of implementing this hydrogen bomb scheme became obvious in the United States.

In the process of working on the “classic super”, a new invention was made, which turned out to be an invention of exceptional significance. Klaus Fuchs, with the participation of John von Neumann, proposed using a new initiation system in the “classic super”. This system included an additional secondary unit of a liquid DT mixture, which was heated, compressed and, as a result, ignited by the radiation energy of the primary atomic bomb /1, 2/.

For this purpose, the use of a primary cannon-type atomic bomb, reinforced according to D. von Neumann's scheme, was considered. It was proposed to transfer the DT mixture of uranium-235 into a beryllium oxide reflector heated by radiation. Fuchs expected that under such conditions the DT mixture would be subjected to heating and ionization implosion, so that the conditions for its thermonuclear ignition would be ensured. To contain radiation in the volume of the reflector, Fuchs proposed surrounding the system with a casing opaque to radiation. Since the ionization compression of the DT mixture in the system under consideration should occur as a result of the transfer of radiation from the active zone of the atomic charge to the thermonuclear fuel location located outside it and be caused by this radiation, it is a radiation implosion. The Fuchs-von Neumann configuration was the first physical scheme to use the principle of radiation implosion, which became the prototype for the future Teller-Ulam configuration.

Documents on the Fuchs-von Neumann scheme were transferred by K. Fuchs to the USSR in 1948. The materials contained general design data, a schematic drawing, power data, calculations of physical processes with tables and graphs (17 sheets in total).

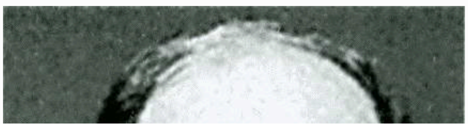
EDWARD TELLER'S "ALARM CLOCK"

Due to difficulties in justifying the Super project, in September 1946, E. Teller proposed an alternative, which he called the Alarm Clock, a layered thermonuclear bomb crimped with explosives. Although the Alarm Clock was a fusion device, only a small portion of its energy output came from fusion reactions. Similar to Project Booster, the thermonuclear reactions in Alarm Clock basically boosted the fission process /1/.

John von Neumann

(1903-1957),

outstanding scientist of the 20th century, American mathematician of Hungarian origin, one of the creators of computer architecture and game theory, co-author of the Monte Carlo method, participant in the development of the first nuclear and thermonuclear charges in the USA



Stanislav (Sten) Ulam

(1909-1984),

American mathematician of Polish origin, co-author of the Monte Carlo method, participant in the development of the first US thermonuclear charges

The Alarm Clock device used a core consisting of successive layers of fissile materials and thermonuclear fuel. Alarm Clock was seen as a system that could provide high energy output using relatively cheap materials. This was a new approach that suggested that a thermonuclear bomb could be created within the existing capabilities of the Los Alamos laboratory, although the path to practical implementation of this idea was not entirely clear.

This device could require 2-3 times more powerful initiating explosion than the Fat Man device provided, i.e. 40-60 kt. Theoretical work on the Alarm Clock continued from the idea's inception in 1946 until the end of 1947; During this time, his scheme was changed several times.

The first full report on Alarm Clock was released in November 1946 by Edward Teller and Robert Richtmyer. It contained a rationale for the possibility of the “Alarm Clock” principle, as well as an assessment of the effectiveness and features of the work. A special study examined the processes that occur during the detonation of a nuclear device. Before a thermonuclear bomb could be created, it was necessary to advance the development of nuclear "triggers" and better understand the process of a nuclear explosion.

In December 1946, an experiment was proposed to test the features of the thermonuclear combustion process under “Alarm Clock” conditions in combination with a nuclear explosion of moderate power.

Klaus Fuchs

(1911-1988),

English and German physicist, leading specialist in atomic and thermonuclear projects in Great Britain and the USA, major specialist in the field of nuclear reactors

In April 1947, the Los Alamos laboratory proposed a whole series of experiments to study thermonuclear processes. It was noted that it is necessary to draw attention to the possibility of testing certain principles, since they may be important for thermonuclear systems, such as the Alarm Clock. It was noted that the possibilities of a purely theoretical study of these principles are insufficient and give an uncertain picture due to the great complexity of the phenomena, therefore a real test of the principles under conditions corresponding to a bomb explosion is highly desirable. When tested, the high temperature created by a nuclear explosion causes thermonuclear reactions. In such a system, the energy produced by fusion reactions may be small, but the 14 MeV neutrons produced in the DT reaction are easy to detect, and the tritium production in the device can be determined if the system originally used only deuterium.

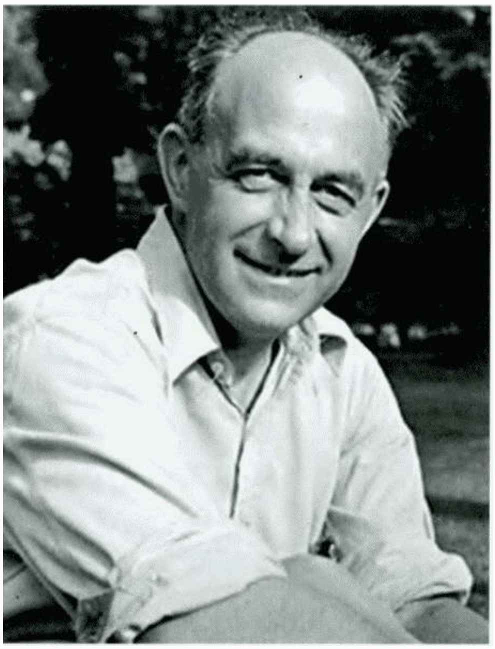
The success of such an experiment depended primarily on the achievement of high temperatures in deuterium, in the context of which radiation transfer is important. A series of three experiments was considered: “A”, “B” and “C”. Test "B" used only deuterium in the fusion fuel; Test "C" used both deuterium and tritium. In both tests, the fusion fuel had to be compressed well. Test "C" was planned to be significantly less sensitive than test "B", and a comparison of the yields of 14-MeV neutrons in them would provide information about the temperatures reached. Test "A" (without thermonuclear processes) was necessary for control. Calculations were carried out for a nucleus from the 8-phase

We note the following, since the "Alarm Clock" was considered as a thermonuclear weapon, it required a large energy release - the megaton class, which created significant difficulties in ensuring the necessary implosion and the level of energy release of the initiating nuclear charge.

In September 1947, Teller proposed using lithium-6 deuteride as the Alarm Clock thermonuclear fuel, which was supposed to increase the efficiency of thermonuclear combustion. The use of lithium deuteride greatly simplified the problem associated with the production of tritium, which at that time limited the development of thermonuclear weapons. However, it required the use of material enriched in the Li-6 isotope and did not solve ignition problems. Teller noted the significant dependence of future successes in the creation of thermonuclear weapons on the development of computers and the achievement of a better understanding of the propagation of shock waves in the mass of thermonuclear fuel.

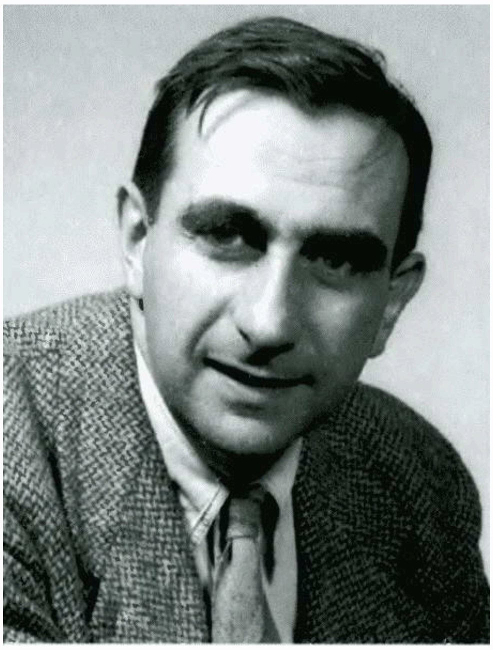
Since September 1947, work on the “Alarm Clock” began to be significantly reduced, although it was carried out in the future. Computer calculations for the original Alarm Clock configuration were completed in 1953-1954. and showed that a device with energy release in this form would be inoperable. The most successful calculations of that time indicated that to obtain an energy release of 10 Mt, the number of explosives in the device should have been from 40 tons to 100 tons.

It should be noted that in the United States many scientists opposed the development of thermonuclear weapons, that is, against work on the “Super” problem.



Enrico Fermi (1901-1954),

outstanding scientist of the 20th century, American physicist of Italian origin, participant in the development of the first nuclear and thermonuclear charges in the USA, developer of the first nuclear reactor in the world (1942), Nobel Prize laureate (1938)



Edward Teller (1908-2003),

American physicist of Hungarian origin, participant in the development of US nuclear and thermonuclear charges

On October 30, 1949, the Atomic Energy Commission met under the chairmanship of R. Oppenheimer, which in its final report spoke out against the development of “Super” /3/. The document was signed by famous scientists and politicians: Oppenheimer, Fermi, Rabi, Conant.

“We believe that a superbomb should not be made under any circumstances. Humanity, until the current situation in the world changes, will live much better without demonstrating the feasibility of this kind of weapon...

TELLER-ULAM CONFIGURATION

The next fundamental stage in the US thermonuclear program dates back to March 1951. On March 9, S. Ulam and E. Teller released a joint report "On Heterocatalytic Detonation 1: Hydrodynamic Lenses and Radiation Mirrors," LAMS-1225, in which they outlined a new concept for constructing a thermonuclear weapons. Born from the unity of the ideas of S. Ulam and E. Teller (which were the development of their own early ideas and the ideas of E. Fermi, E. Konopinsky, D. von Neumann and K. Fuchs), the new superbomb scheme was called the "Teller-Ulam configuration".

A few weeks later, Teller proposed another improvement to the hydrogen bomb - "to use an atomic bomb as an initiator in thermonuclear fuel" /3/.

As Edward Teller noted in his memoirs, the rationale and choice of the specific Mike design was made largely over several months in the summer and fall of 1951 by a young Los Alamos specialist, Dick Garwin, based on an analysis of numerical calculations. carried out on a computer by a group of mathematicians from Los Alamos.

At the same time, preparations were being made for a test in which the Fuchs-von Neumann configuration was essentially tested. On May 9, 1951, the "George" test was successfully carried out /4/. The power of the explosion was 225 kg T.E. "The largest fission explosion to date ignited a small thermonuclear flame, the first ever to ignite on Earth." The test confirmed theoretical ideas about the possibility of combustion of the DT mixture, part of which was located outside the fissile material of the primary atomic bomb. Having been one of the main sources of the discovery of the Teller-Ulam configuration, the "George" experiment played its main role even before its implementation (Appendix 1 of this book provides more detailed information about this unique experiment).

The growing attention to the creation of thermonuclear charges is indicated by the fact that in June 1951, a conference on the problems of the superbomb was held in Princeton, which recognized the need for the production of lithium-6 deuteride.

In September 1951, at Los Alamos, a decision was made to develop a thermonuclear device based on a new principle (radiation implosion, Teller-Ulam configuration) for the full-scale Mike test, scheduled for November 1, 1952. Liquid deuterium was chosen as the thermonuclear fuel . The Mike device consisted of a massive steel cylinder containing a primary charge based on the principle of implosion and a huge steel "thermos" containing several hundred liters of liquid deuterium inside a massive shell of natural uranium, which was a thermonuclear module /4/.

Before testing, the Mike's energy release was estimated at 1-10 Mt, with a probable value of 5 Mt, but the possibility of an energy release of 50-90 Mt was not excluded. The main uncertainty in the energy release forecast was associated with uncertainty in the efficiency of thermonuclear combustion and in the efficiency of fission of the uranium shell (uranium-238) by thermonuclear neutrons. The efficiency of thermonuclear combustion was due to new and complex physics that could not be accurately calculated at the time. The efficiency of fission of the uranium shell depended to a large extent on the compression of the thermonuclear module, which was determined with a significant error. Some features of the Mike device are given in Appendix 2.

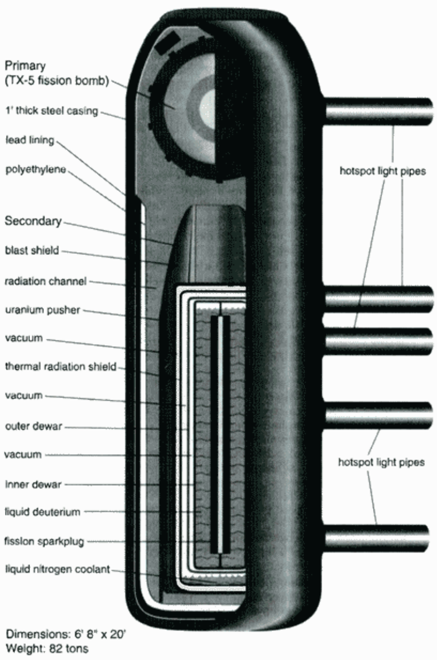
The successful test of "Mike" led to the next decisive step - the development in 1954 of powerful thermonuclear charges in the "Castle" series, which were mentioned above. It should be noted that despite the gigantic energy resources, compared to chemical explosives, the principle of radiation implosion itself (Teller-Ulam configuration) did not guarantee success.

The values of forecasts of energy release of powerful thermonuclear charges in the "Castle" series, made by US specialists before conducting full-scale experiments, are given in the table on p. 30. Let us emphasize that the computing capabilities possessed by US nuclear laboratories significantly exceeded the computing capabilities of our country during the development of RDS-37.

Точность прогнозов мощности термоядерных зарядов в 1954 г. /13/

Испытание	Название заряда	Дата испытаний (местное время)	Расчетный диапазон мощности, Мт	Наиболее вероятная расчетная мощность, Мт	Экспериментальная мощность, Мт	Ошибка
Bravo	Shrimp	1 марта	4–8	6	15	в 2,5 раза
Romeo	Runt I	27 марта	1,5–15т	8	11	в 1,4 раза
Koon*	Morgenstern	7 апреля	0,33–4	1,5	110	в 13,5 раз
Union	Alarm Clock	26 апреля	1–18	5–10	6,9	в 1,1 раза
Yankee	Runt II	5 мая	7,5–15	9,5	13,5	в 1,4 раза
Nectar	Zombie	14 мая	1–5 Мт	2–3 Мт	1,69 Мт	в 1,5 раза

** All tests were conducted by the Los Alamos Laboratory, except "Coop", the first failed test by the Livermore Laboratory.*



US two-stage charge with a capacity of 10.4 Mt, tested on November 1, 1952 /5/

4. FIRST STAGES OF THE USSR THERMONUCLEAR PROGRAM

RDS-6s explosion

Work on the creation of thermonuclear weapons in the USSR began in 1945, when it became known that work on a superbomb (the "Super" project) was being carried out in the USA. The first information about work in the United States on a superbomb arrived in the USSR through intelligence channels and the media in the second half of 1945.

The most important information was provided to the USSR by an employee of the theoretical department of the Los Alamos National Laboratory in the USA, a member of the British mission in Los Alamos, Klaus Fuchs.

Information received in 1945 about work in the United States on a superbomb could not help but worry the political and scientific leaders of the Soviet atomic project. I.V. Kurchatov turned to prominent physicists of the USSR, among whom were specialists in the theory of detonation (I.I. Gurevich, Ya.B. Zeldovich, I.Ya. Pomeranchuk and Yu.B. Khariton), informing them of the formulation of the problem and some initial data , with a proposal to otherwise independently consider the possibility of carrying out nuclear detonation in a cylinder of deuterium using the explosion of an atomic bomb (Fuchs's material was devoted to this direction of creating a superbomb).

* * *

Foreign press and intelligence reports about the possibility of creating megaton-class bombs /6, p. 10/

Bombs are 100 times stronger

(The Times, 10/19/45)

Professor Oliphant, speaking in Birmingham on 18.10, said that the atomic bombs used against Japan were now obsolete. Bombs 100 times stronger, i.e., equal to 2 million tons of explosives, can now be produced. The professor believes that it is possible to create a bomb 1000 times stronger, the explosion of which will poison an area of 2000 square miles. The professor also said that back in 1942, scientists could control the decay of uranium and generate electricity up to 1 million kilowatts.

From information material No. 257 /6, p. eleven/

(The material was presented by Bureau No. 2 at a meeting of the technical council of the Special Committee under the Council of People's Commissars of the USSR on October 22, 1945)

<…> Work is underway to create a superbomb, the power of which can be increased to 1 million tons of TNT. <… > The principle of a superbomb is to use a small amount of uranium-235 or plutonium-239 as a primary source to cause a nuclear chain reaction in some substance that is less scarce. Correct: Zemskov.

From information material No. 256 /6, p. 10/

(The material was presented by Bureau No. 2 at a meeting of the technical council of the Special Committee under the Council of People's Commissars of the USSR on October 22, 1945)

Superbomb

<...> Using bombs with "25" or "49" as an auxiliary means, they hope to cause a nuclear reaction in light nuclei. Perhaps this plan is possible, but it still requires a lot of development and is not of immediate interest.

The transmitted material contained data on the concept of the "Super" project and a series of lectures

Enrico Fermi about the physical processes that occur in such a thermonuclear system. The same materials noted the possibility of producing tritium, necessary for the transition section initiating the deuterium cylinder, in nuclear reactors during neutron capture on lithium-6.

Already on January 1, 1946 Yu.B. Khariton in his "Note" notes that "in principle, nuclear detonation of light elements is possible, and the most suitable substance is heavy hydrogen."

Igor Vasilievich Kurchatov

(1903-1960),

outstanding physicist and organizer of science, academician, scientific director of the Atomic Project, head of Laboratory No. 2 of the USSR Academy of Sciences -

Institute of Atomic Energy (1943-1960) (now the Russian Scientific Center

"Kurchatov Institute"), three times Hero of Socialist Labor,

laureate of Lenin and four State Prizes

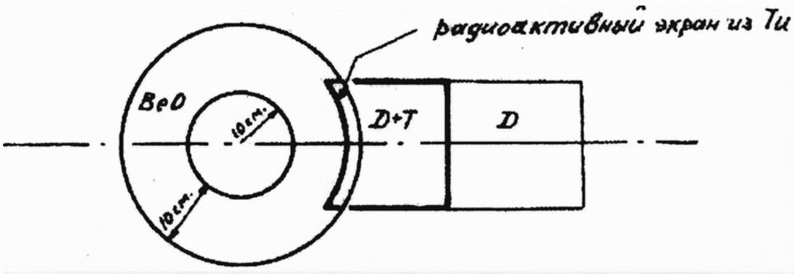
Yuliy Borisovich Khariton

(1904-1996),

outstanding physicist and organizer of science, academician, chief designer of KB-11 (1946-1952), chief designer and scientific director of KB-11 (1952-1959), scientific director of VNIIEF (1959-1992), honorary scientific director of RFNC-VNIIEF (1992 -1996), three times Hero of Socialist Labor, laureate of Lenin and three State Prizes

***

In the lectures of E. Fermi, transmitted by our intelligence on January 28, 1946 to the First Main Directorate for information by I.V. Kurchatova and Yu.B. Khariton, various mechanisms of thermonuclear reactions in deuterium and a mixture of deuterium and tritium were examined in detail. The lectures also provide a simplified diagram of a thermonuclear bomb “pipe”/6, p. 24/.



It concludes that “all the projects hitherto presented regarding excitation in a superbomb are very vague. The one that deserves the most preference is this: in the center is a bomb with a "25"[2] (about 100 kg "25") cannon type. It is surrounded by a BeO filler, which reflects neutrons well and transmits radiation. Part of the BeO surface is coated with uranium metal as a radiation protector. Behind this fuse is a D+T mixture, heated by neutrons coming from the bomb.

If a magnetic field is applied, the D+T mixture can be ring-shaped. In this case, only transverse thermal conductivity matters. Behind the D+T mixture is pure D.”

RESEARCH ON THE DEUTERIUM BOMB IN THE USSR

I.I. Gurevich, Ya.B. Zeldovich, I.Ya. Pomeranchuk and Yu.B. Khariton prepared materials “The Use of Nuclear Energy of Light Elements,” which were heard at a meeting of the technical council of the Special Committee of the Council of People's Commissars of the USSR on December 17, 1945. In the report made by Ya.B. Zeldovich, considered the possibility of excitation of thermonuclear detonation in a cylinder with deuterium under conditions of a nonequilibrium combustion mode /6, p. 19/. In 1991, this report was published in full.

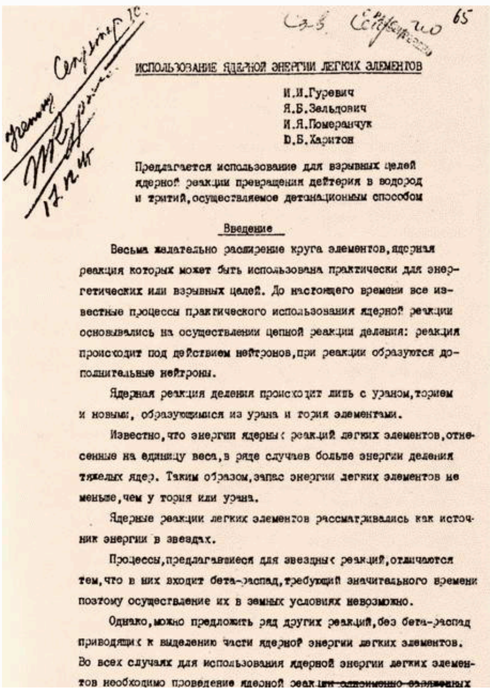
Of interest is the decision of the technical council on the report - the first official decision regarding work in the USSR on the hydrogen bomb:

"1. It is considered necessary to carry out systematic measurements of the efficiency of cross sections in the nuclei of light elements, using for this purpose a high-voltage electrostatic generator of the Kharkov Institute of Physics and Technology.

2. Instruct Professor Ya.B. Zeldovich, within three days, prepare a task to study reactions in the nuclei of light elements and submit them for consideration by the technical council.”

Noteworthy is the fact that the decision of the technical council concerns only the base of initial experimental data and does not contain instructions related to the organization and conduct of theoretical calculations to study the possibility of creating a superbomb.

Since June 1946, theoretical studies of the possibility of using nuclear energy of light elements began to be carried out at the Institute of Chemical Physics (in Moscow) by a group consisting of S.P. Dyakov and A.S. Kompaneets under the leadership of Ya.B. Zeldovich. The first results of the work of this group were discussed at a meeting of the Scientific and Technical Council of the First Main Directorate, held on November 3, 1947.



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ИСПОЛЬЗОВАНИЕ ЯДЕРНОЙ ЭНЕРГИИ ЛЕГКИХ ЭЛЕМЕНТОВ

И.И.Гуревич
Я.Б.Зельдович
И.Я.Померанчук
Ю.Б.Харитон

Предлагается использование для взрывных целей ядерной реакции превращения дейтерия в водород и тритий, осуществляемое детонационным способом

Введение

Весьма желательно расширение круга элементов, ядерная реакция которых может быть использована практически для энергетических или взрывных целей. До настоящего времени все известные процессы практического использования ядерной реакции основывались на осуществлении цепной реакции деления: реакция происходит под действием нейтронов, при реакции образуются дополнительные нейтроны.

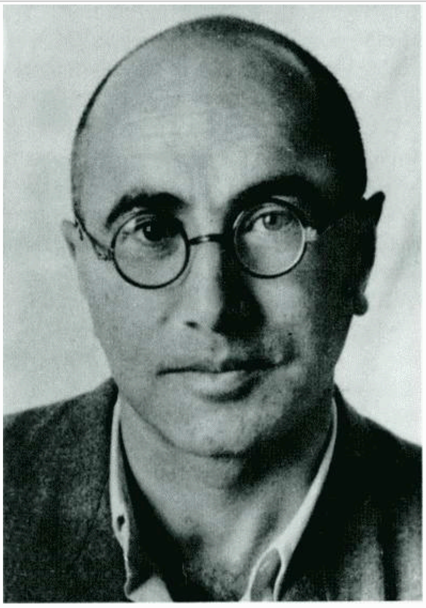
Ядерная реакция деления происходит лишь с ураном, торием и новыми, образующимися из урана и тория элементами.

Известно, что энергии ядерных реакций легких элементов, отнесенные на единицу веса, в ряде случаев больше энергии деления тяжелых ядер. Таким образом, запас энергии легких элементов не меньше, чем у тория или урана.

Ядерные реакции легких элементов рассматривались как источник энергии в звездах.

Процессы, предлагавшиеся для звездных реакций, отличаются тем, что в них входит бета-распад, требующий значительного времени поэтому осуществление их в земных условиях невозможно.

Однако, можно предложить ряд других реакций, без бета-распад приводящих к выделению части ядерной энергии легких элементов. Во всех случаях для использования ядерной энергии легких элементов необходимо проведение ядерной реакции



Yakov Borisovich Zeldovich

(1914-1987),

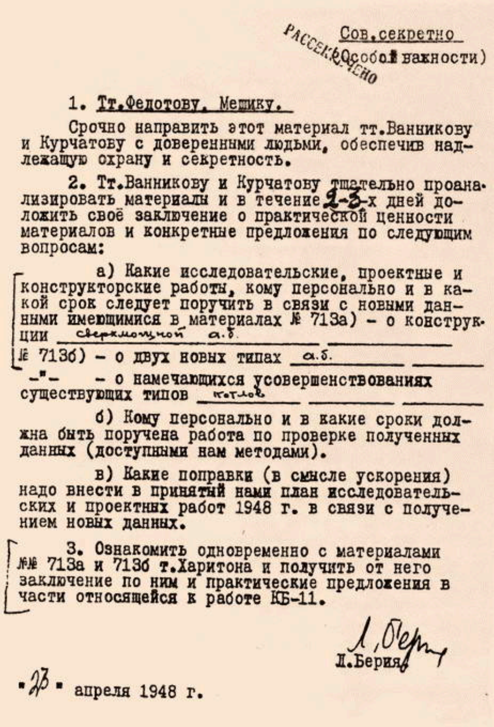
outstanding theoretical physicist, academician, creator of the first samples of nuclear and thermonuclear charges, three times Hero of Socialist Labor, laureate of Lenin and four State Prizes, worked at KB-11 (VNIIEF) in 1948-1965.

A report by S.P. was prepared for the meeting of the Scientific and Technical Council of PGU. Dyakova, Ya.B. Zeldovich and A.S. Kompaneets "On the issue of using intra-atomic energy of light elements", a report based on it was presented by Ya.B. Zeldovich.

Basics of the approach in the report by S.P.Dyakova, Ya.B. Zeldovich and A.S. Kompaneitsa - the same as in the report of I.I. Gurevich, Ya.B. Zeldovich, I.Ya. Pomeranchuk and Yu.B. Khariton 1945 - elucidation of the conditions under which nuclear detonation may be possible in a medium of light nuclei, propagating as a result of the passage of a shock wave in conditions of lack of thermal equilibrium between matter and radiation. The possibility of carrying out such a detonation both in a medium of deuterium and in a medium of natural lithium deuteride was considered.

As noted by Ya.B. Zeldovich, it was not possible to draw any definite conclusions at that time about the practical possibility of using the nuclear energy of light elements without additional theoretical calculations and experimental studies.

The decision of the Scientific and Technical Council of PGU dated November 3, 1947 noted the importance of the work being carried out at the Institute of Chemical Physics of the USSR Academy of Sciences to study the possibility of using the energy of light elements for the development of nuclear physics and, in the case of a positive solution to this problem, for practical purposes. The need to continue this work is indicated, first of all, to study the conditions for the implementation of reactions in light elements using the phenomenon of detonation when initiated by an atomic explosion.



РАССЕКРЕЧЕНО

Сов.секретно
(Особой важности)

1. Тт.Федотову, Мешику.

Срочно направить этот материал тт.Ванникову и Курчатову с доверенными людьми, обеспечив надлежащую охрану и секретность.

2. Тт.Ванникову и Курчатову тщательно проанализировать материалы и в течение 2-3-х дней доложить своё заключение о практической ценности материалов и конкретные предложения по следующим вопросам:

а) Какие исследовательские, проектные и конструкторские работы, кому персонально и в какой срок следует поручить в связи с новыми данными имеющимися в материалах № 713а) – о конструкции сверхмощной а.б.

№ 713б) – о двух новых типах а.б.

-"- – о намечающихся усовершенствованиях существующих типов котлов

б) Кому персонально и в какие сроки должна быть поручена работа по проверке полученных данных (доступными нам методами).

в) Какие поправки (в смысле ускорения) надо внести в принятый нами план исследовательских и проектных работ 1948 г. в связи с получением новых данных.

3. Ознакомить одновременно с материалами №№ 713а и 713б т.Харитона и получить от него заключение по ним и практические предложения в части относящейся к работе КБ-11.

Л.Берия

"23" апреля 1948 г.

April 23, 1948 L.P. Beria instructed B.L. Vannikov, I.V. Kurchatov and Yu.B. Khariton to carefully analyze the materials on the Fuchs-von Neumann system, transmitted in 1948 by Klaus Fuchs, and prepare proposals for organizing the necessary research and work in connection with the receipt of these new materials /6, p. 112/. Conclusions on Fuchs' new materials were presented by Yu.B. Khariton, B.L. Vannikov and I.V. Kurchatov May 5, 1948

These materials gave a new impetus to the development of research in the USSR on the problem of the hydrogen bomb, which received the

determination of the maximum diameter required to ensure combustion of pure deuterium or a mixture of deuterium and tritium;

analysis of the effect of different amounts of tritium in a mixture with deuterium on the reaction rate;

study of deuterium ignition from a mixture of deuterium and tritium;

study of the influence of the energy release of the primary nuclear charge on the ignition process;

study of the influence of the physical properties of the RDS-2 shell on the ignition process;

study of the features of the action of radiation, neutrons and charged particles during the ignition process.

KB-11 was supposed to carry out this work with the participation of the Physical Institute of the USSR Academy of Sciences. To carry out this work, it was ordered to create a special theoretical group at the Physical Institute under the leadership of I.E. Tamma. The group included S.3. Belenky, A.D. Sakharov, V.L. Ginzburg and Yu.A. Romanov. To coordinate theoretical and computational work and monitor the implementation of tasks, it was ordered to create a special closed seminar at Laboratory No. 2 under the leadership of S.L. Sobolev (L.D. Landau, I.G. Petrovsky, S.L. Sobolev, V.A. Fok, Ya.B. Zeldovich, I.E. Tamm, A.N. Tikhonov, Yu.B. Khariton, K.I. Shchelkin).

The Super type hydrogen bomb received the RDS-6t index. Many remarkable scientists participated in the work on the RDS-6t project, and the leadership of physical research in it was carried out by the outstanding theoretical physicist Ya.B. Zeldovich /6, p. 325, 327/.

The underlying fundamental problems studied in this project included, in particular: cross sections and energetics of DD and DT reactions; issues of Maxwellization of nuclei and electrons; neutron-nuclear interactions in igniting and burning deuterium plasma;

radiation processes during heating and cooling of plasma under nonequilibrium conditions;

hydrodynamics of deuterium plasma.

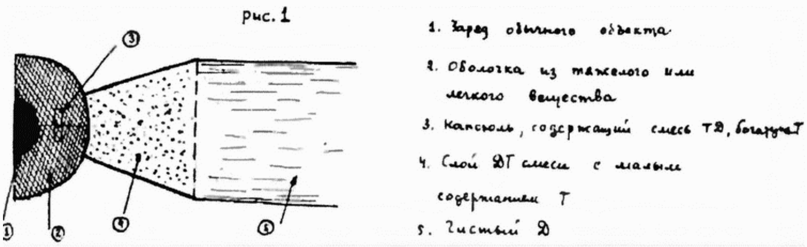
During the initial period of work on the project, experimental data on many of the determining processes were extremely scarce; There were no computing capabilities. As the authors of the final work on the RDS-6t project noted in 1953, “the joint solution of all the equations of this problem, which simultaneously take into account all the processes occurring in the system, is practically impossible until the development of computer mathematical technology. Therefore, it was necessary to separate the solutions to three main problems: a) hydrodynamics; b) kinetics of nuclear reactions and diffusion of fast particles arising during reactions; c) radiation." The assessment of the state of work on RDS-6t is well characterized by the decision of the NTS PGU at the beginning of 1951, which is given in Appendix 3.

The RDS-6t project was closed by 1954 /7, p.287/, when the absence of a stable combustion regime for such implosion-free systems was finally established. However, these works turned out to be extremely useful for understanding many issues related to the ignition and combustion of a thermonuclear environment.

***

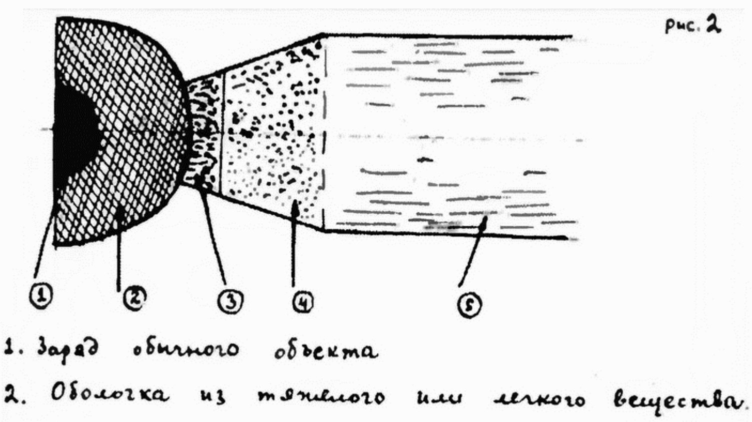
On October 26, 1950, a detailed report from Ya.B.'s employees was published. Zeldovich, N.A. Dmitrieva, G.M. Gandelman, V.Yu. Gavrilova, “On the theory of initiator for “T””/6, p. 324/, which considered various schemes for initiating thermonuclear fuel (deuterium) in the “pipe”

“At present, the following basic schemes for initiating a thermal explosion in “T” seem conceivable to us:



In this scheme, a capsule containing a T-rich TD mixture is compressed to a very high density when the object's internal charge expands, and the TD mixture is ignited by the energy released when the object explodes. The 14-MeV neutrons appearing during the combustion of the mixture exit through the shell (partially absorbed and slowed down in it), ignite the TD layer containing a low concentration of T. The shock wave and fast particles arising during the combustion of this layer ignite the D layer closely adjacent to this layer The layer of inert substance provided in this embodiment, separating the capsule 3 from layer 4 (Fig. 1), on the one hand, ensures the density of the capsule substance and delays the release of radiation, which is formed during the combustion of the central charge, into layer 4. On the other hand, in. With such a design, very significant losses of n with an energy of 14 MeV are inevitable due to their slowing down and absorption in the layer of inert matter and the inevitable decrease in the solid angle at which the capsule is visible from any point in layer 4.

Let us now move on to the second conceivable design (Fig. 2).



4. Слой смеси ТД с малым содержанием Т
5. чистый Д

In this scheme, capsule 3 is compressed relatively little (only by the shock wave emerging from the shell). In addition, the beginning of combustion of the capsule substance will, apparently, practically coincide with the moment of the release of the radiation that appeared during the combustion of the central charge into layer 4. The presence of this radiation can significantly complicate or make it impossible for the ignition of the lean T-mixture in layer 4."

The report concluded "that as a result of the reaction of a TD mixture surrounded by heavy material, a shock wave propagating through the heavy material heats and compresses the TD mixture (this preliminary part of the process is not considered). In the heated mixture, a reaction begins and a rapid increase in temperature occurs, reaching 100-200 keV. In this case, more than half of T burns out in less than 2-10^{-9} s.

Thus, the possibility of creating a very powerful n pulse with an energy of 14 MeV has been demonstrated, which can be used to ignite a TD mixture located outside a heavy substance."

***

It should be noted that this project was closed at the suggestion of KB-11 scientists long before the testing of RDS-37.

During the development of RDS-6t, fundamental experimental data were obtained on the cross sections of thermonuclear reactions and the interaction of thermonuclear fuel nuclei with neutrons. Appendix 4 c contains fragments of the nuclear physics research plan that KB-11 considered necessary to carry out to solve this problem. These studies determined the fundamental parameters of thermonuclear processes and were one of the foundations for the further development of thermonuclear charges, including RDS-37.

DEVELOPMENT OF LAYER THERMONUCLEAR CHARGE RDS-6S

Another direction of work on creating a thermonuclear charge was associated with research carried out by a group of employees under the leadership of I.E. Tamm, and above all with the research of A.D. Sakharov. Initially, the employees of this group, in accordance with the stipulated plan of work on the hydrogen bomb, became familiar with the calculations of Ya.B.'s group at the Institute of Chemical Physics. Zeldovich and checked these calculations.

A few months after the start of the work of I.E.'s group. Tamm on special topics A.D. Sakharov began to consider the possibility of creating a hydrogen bomb by igniting a nuclear detonation by an atomic explosion in a heterogeneous flat system with alternating layers of thermonuclear fuel and uranium-238. The basis of this approach was the idea that at temperatures of tens of millions of degrees, realized during a nuclear explosion, layers of thermonuclear fuel placed between layers of uranium, as a result of equalization of pressures in thermonuclear fuel and uranium in the process of ionization of the substance, acquire a high density, as a result of which The rate of thermonuclear reactions increases significantly /7, p. 178/.

A note with a proposal to stop work on the RDS-6t product

December 10, 1954

To Comrade Malyshev V. A At the beginning of this year, under your chairmanship, a meeting was held on the problem of T (detonation of a cylindrical charge made of liquid deuterium). At the meeting, it was decided to release KB-11 from work on this problem with a transition to work on the AO (atomic compression) problem, as more promising. At the same time, it was decided that the groups D.I. Blokhintseva, I.M. Gelfand and A.S. Kronroda can continue working on the T problem, since they were enthusiasts of this problem. All data obtained since then confirm that the T problem is not practically relevant for the reasons detailed in the minutes of the said meeting 1. On the contrary, the preliminary work carried out on the AO problem has confirmed its real prospects. In connection with the above, we ask for your order to completely stop work on the T problem with switching groups I.M. Gelfand and A.S. Kronrod to complete our tasks related to the problem of A.O. Group I.M. Gelfand, we consider it appropriate to entrust calculations on the stability of spherical compression to the group of A.S. Kronroda - calculations of the equation of state and thermal conductivity under the conditions of A.O.

A.S. Alexandrov,
Yu.B. Khariton,
I WOULD. Zeldovich,
YES. Frank-Kamenetsky

***

Andrey Dmitrievich Sakharov

(1921-1989),

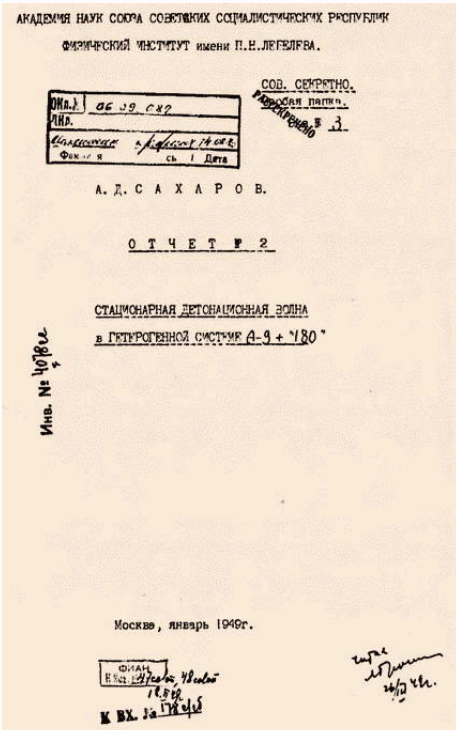
outstanding theoretical physicist, academician, creator of the first samples of thermonuclear charges, three times Hero of Socialist Labor, laureate of the Lenin and State Prizes, laureate of the Nobel Peace Prize, worked at VNIIEF in 1950-1968. HELL. At the first stage of work on layered systems, Sakharov also considered a cylindrical system, and the use of heavy water was envisaged as a thermonuclear fuel.

However, already in November 1948, group employee I.E. Tamma V.L. Ginzburg issued a report in which he proposed using a new thermonuclear fuel in the layered system - lithium-6 deuteride, which forms tritium when neutrons are captured /6, p. 178/.

The idea of the “puff paste” and the idea of using lithium-6 deuteride are the “first” and “second” ideas, in the terminology of “Memoirs” by A.D. Sakharov /8/ - became the key ideas that later formed the basis for the development of the first Soviet hydrogen bomb RDS-6s. However, despite the clarity of the initial physical ideas of the “puff”, formulated in 1948, the path to creating a real structure based on them was not easy.

In June 1949, a series of meetings were held at KB-11 to review the status of work on the RDS-1, RDS-2, RDS-3, RDS-4, RDS-5 atomic bombs and the status of work on the RDS-6 hydrogen bomb.

A paper written by A.D. was presented at the meeting. Sakharov plan for theoretical and experimental research for 1949-1950 related to the development of RDS-6s. The theoretical part of the plan had two large sections: 1) study of the mechanism of propagation of a stationary detonation wave in layered systems; 2) theoretical studies of the possibility of high-temperature detonation of deuterium. Among many subsections, paragraph 1 of the plan contained the subsection “Study of the possibility of increasing the reactivity of RDS-6 type systems through compression with a conventional explosive.” This was a significant advance, while the original idea of the “puff layer” assumed the possibility of carrying out nuclear detonation in an uncompressible system of layers of uranium and thermonuclear fuel of normal density. The idea of the puff pastry merged with the idea of implosion.



АКАДЕМИЯ НАУК СОЮЗА СОВЕТСКИХ СОЦИАЛИСТИЧЕСКИХ РЕСПУБЛИК

ФИЗИЧЕСКИЙ ИНСТИТУТ имени П.Н.ЛЕБЕДЕВА.

СОВ. СЕКРЕТНО.
Особая папка.
№ 3

РАССЕКРЕЧЕНО

Экз. № 06 39 с82
Инв.
Фамилия, подпись, дата

Инв. № 4078с

А. Д. С А Х А Р О В.

О Т Ч Е Т № 2

СТАЦИОНАРНАЯ ДЕТОНАЦИОННАЯ ВОЛНА
в ГЕТЕРОГЕННОЙ СИСТЕМЕ А-9 + "180"

Москва, январь 1949г.

ФИАН
К ВХ. №

A month after the US President announced the start of large-scale work on the development of a superbomb (hydrogen bomb), Decree of the USSR Council of Ministers No. 827-808 “On work to create an RDS” was issued, which obligated the First Main Directorate, Laboratory No. 2, the USSR Academy of Sciences and KB-11 carry out calculation-theoretical, experimental and design work to create the product RDS-6s (“puff pastry”) and RDS-6t (“pipe”). First of all, the RDS-6s product had to be created with a TNT equivalent of 1 million tons and a weight of 5 tons/6.s. 288/.

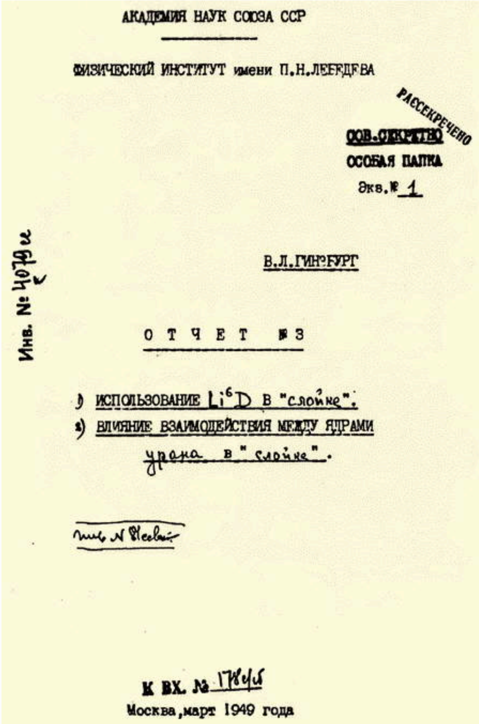
By this Decree of the Council of Ministers of the USSR dated February 26, 1950, work on the hydrogen bomb was concentrated in KB-11, for its implementation the group of I.E. Tamma was sent in 1950 to permanent work in Arzamas-16. Yu. B. Khariton was appointed scientific supervisor of the work on the creation of the RDS-6s and RDS-6t products, his deputies were I.E. Tamm and Ya.B. Zeldovich.

At the same time, Resolution of the Council of Ministers of the USSR No. 828-304 “On the organization of tritium production” was adopted.

It should be emphasized that, although in ideological terms “Alarm Clock” and RDS-6s are very close, there is a significant difference between them. This difference is primarily due to the level of energy release. The fact that the Alarm Clock was considered a megaton class charge (a competitor to the Super) determined its large size, which in turn created design difficulties and problems regarding the possibilities of its practical application. As a result, this project turned out to be unviable and was not implemented.

The RDS-6s was created in relation to the conditions of placement in a real aerial bomb, and its creation required, first of all, to achieve a significant gain in energy release compared to purely nuclear charges (the energy release of which at that time did not exceed 40 kt). This was a more pragmatic approach, which made it possible to create the RDS-6s as a model of a megaton-class charge and at the same time significantly exceed the performance of nuclear charges.

When they began to solve the problem of increasing the energy release in a charge of the RDS-6s type to the megaton level, difficulties arose.


АКАДЕМИЯ НАУК СОЮЗА ССР

ФИЗИЧЕСКИЙ ИНСТИТУТ имени П.Н.ЛЕБЕДЕВА

РАССЕКРЕЧЕНО

СОВ.СЕКРЕТНО
ОСОБАЯ ПАПКА
Экз.№ 1

Инв. № 4079 ис

В.Л.ГИНЗБУРГ

ОТЧЕТ №3

1) ИСПОЛЬЗОВАНИЕ Li^6D В "слойке".
2) ВЛИЯНИЕ ВЗАИМОДЕЙСТВИЯ МЕЖДУ ЯДРАМИ урана в "слойке".

К ВХ. № 17845
Москва, март 1949 года

Developed in 1950-1953. in KB-11, the RDS-6s thermonuclear charge, which was the first thermonuclear charge of the USSR, was a spherical system of layers of uranium and thermonuclear fuel, surrounded by a chemical explosive. To increase the energy release of the charge, tritium was used in its design. Using well-known terminology, we can say that the RDS-6s thermonuclear charge was made according to a single-stage scheme.

The design features and physics of operation of the RDS-6s are discussed in detail in a number of publications /9-12/.

As noted in his "Memoirs" by A.D. Sakharov /8/, "preparation for testing the first thermonuclear charge was a significant part of the entire work of the "object" in 1950-1953, as well as other organizations and enterprises of our management and many involved organizations. This was work that included, in particular, experimental and theoretical studies of gas-dynamic explosion processes, nuclear physics research, design work in the truest sense of the word, development of automation and electrical circuits of the product, development of unique equipment and new techniques for recording physical processes and determining power explosion.

Enormous efforts involving a large number of people and large material costs required the production of the substances included in the product, as well as other production and technological work.

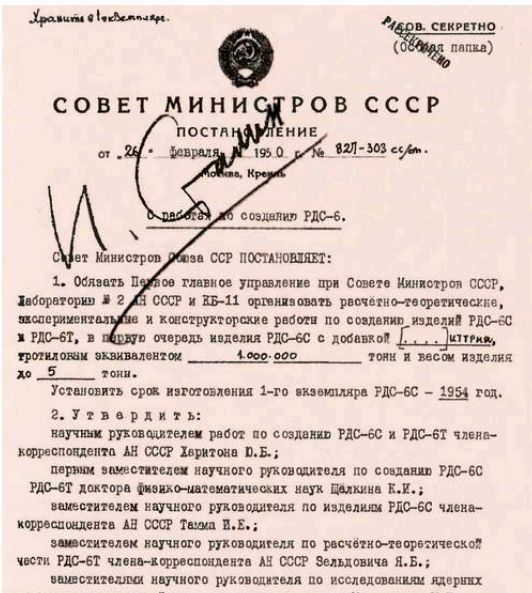
The drama of the development of the RDS-6s lay in the fact that it took place against the background of the US news of the testing of thermonuclear bombs in 1952.

There followed an immediate order from L. Beria to speed up our work.

Theoretical groups played a special role in all preparations for testing the first thermonuclear. Their tasks were to select the main directions for product development, evaluate and general theoretical work related to the explosion process, select product options and supervise specific calculations of explosion processes in various options. These calculations were carried out using numerical methods, in those years - in special mathematical groups created at some research institutes.

Theoretical groups also played an important role in defining tasks, analyzing results, discussing and coordinating almost all of the listed areas of work of other divisions of the "object" and involved organizations."

The general management of the work on RDS-6s was carried out by I.V. Kurchatov. The chief designer and immediate supervisor of the work was Yu.B. Khariton.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СОВ. СЕКРЕТНО
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РАССЕКРЕЧЕНО

СОВЕТ МИНИСТРОВ СССР
ПОСТАНОВЛЕНИЕ
от 26 февраля 1950 г. № 827-303 сс/оп.
Москва, Кремль

И. Сталин

О работах по созданию РДС-6.

Совет Министров Союза ССР ПОСТАНОВЛЯЕТ:

1. Обязать Первое главное управление при Совете Министров СССР, Лабораторию № 2 АН СССР и КБ-11 организовать расчётно-теоретические, экспериментальные и конструкторские работы по созданию изделий РДС-6С и РДС-6Т, в первую очередь изделия РДС-6С с добавкой [. . . .] трития, тротиловым эквивалентом 1.000.000 тонн и весом изделия до 5 тонн.

Установить срок изготовления 1-го экземпляра РДС-6С – 1954 год.

2. Утвердить:

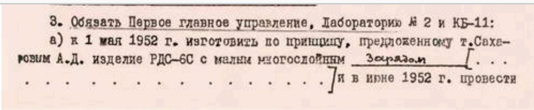
научным руководителем работ по созданию РДС-6С и РДС-6Т члена-корреспондента АН СССР Харитона Ю.Б.;

первым заместителем научного руководителя по созданию РДС-6С РДС-6Т доктора физико-математических наук Щёлкина К.И.;

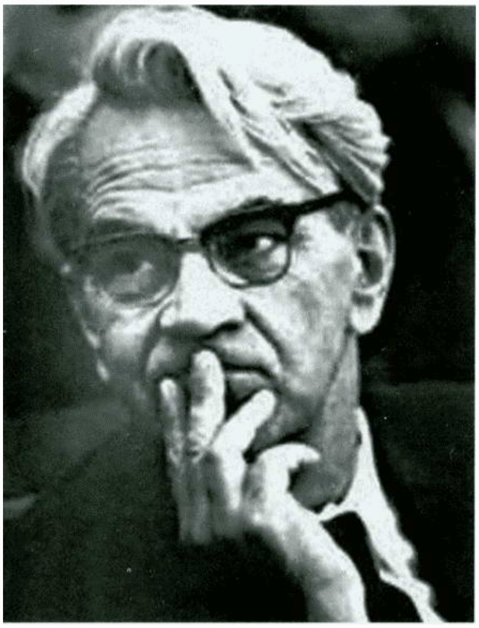
заместителем научного руководителя по изделиям РДС-6С члена-корреспондента АН СССР Тамма И.Е.;

заместителем научного руководителя по расчётно-теоретической части РДС-6Т члена-корреспондента АН СССР Зельдовича Я.Б.;

заместителями научного руководителя по исследованиям ядерных



3. Обязать Первое главное управление, Лабораторию № 2 и КБ-11:
а) к 1 мая 1952 г. изготовить по принципу, предложенному т.Сахаровым А.Д. изделие РДС-6С с малым многослойным зарядом [. . . . .] и в июне 1952 г. провести



Mstislav Vsevolodovich Keldysh

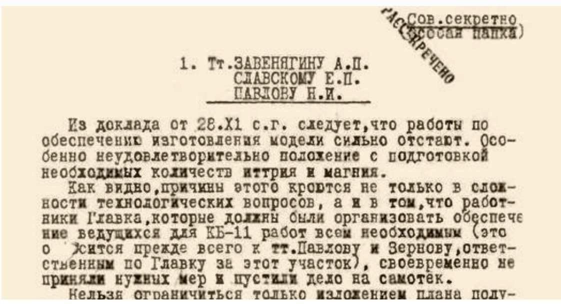
(1911-1978),

outstanding mathematician of the 20th century, active participant and organizer of nuclear missile projects of the USSR, participant in nuclear tests, author of fundamental works in applied mathematics and physics, made an outstanding contribution to the development of computational mathematics, director and organizer of the Institute of Applied Mathematics of the USSR Academy of Sciences, President of the USSR Academy of Sciences, three times Hero of Socialist Labor, laureate of Lenin and two State Prizes

Andrey Nikolaevich Tikhonov

(1906-1993),

outstanding mathematician of the 20th century, academician, founder of a scientific school, one of the initiators of the use of numerical methods for the development of atomic and hydrogen bombs, director of the Institute of Applied Mathematics of the USSR Academy of Sciences, twice Hero of Socialist Labor, laureate of Lenin and two State Prizes



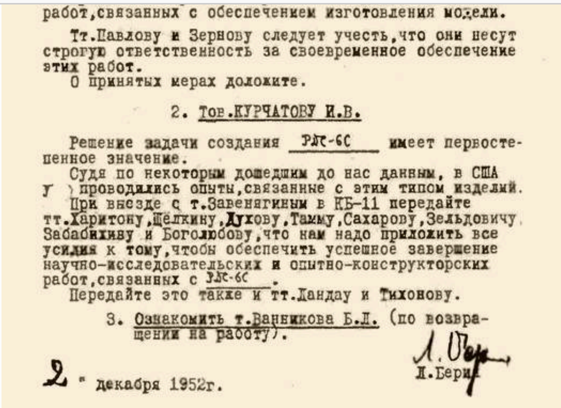
Сов.секретно
(Особая папка)
РАССЕКРЕЧЕНО

1. Тт.ЗАВЕНЯГИНУ А.П.
СЛАВСКОМУ Е.П.
ПАВЛОВУ Н.И.

Из доклада от 28.XI с.г. следует, что работы по обеспечению изготовления модели сильно отстают. Особенно неудовлетворительно положение с подготовкой необходимых количеств иттрия и магния.

Как видно, причины этого кроются не только в сложности технологических вопросов, а и в том, что работники Главка, которые должны были организовать обеспечение ведущихся для КБ-11 работ всем необходимым (это о[тно]сится прежде всего к тт.Павлову и Зернову, ответственным по Главку за этот участок), своевременно не приняли нужных мер и пустили дело на самотёк.

Нельзя ограничиться только изложением плана полу-


работ, связанных с обеспечением изготовления модели.

Тт. Павлову и Зернову следует учесть, что они несут строгую ответственность за своевременное обеспечение этих работ.

О принятых мерах доложите.

2. Тов. КУРЧАТОВУ И.В.

Решение задачи создания РДС-6С имеет первостепенное значение.

Судя по некоторым дошедшим до нас данным, в США проводились опыты, связанные с этим типом изделий.

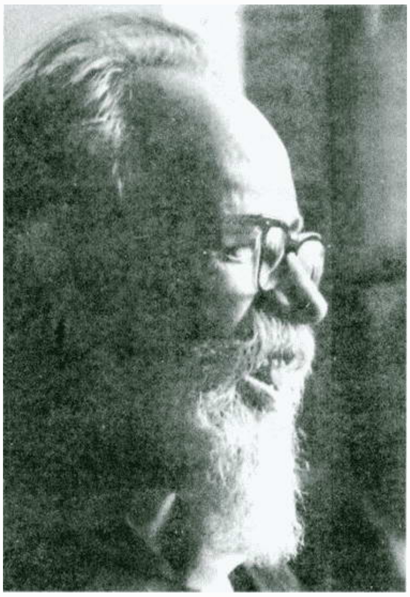
При внезде с т. Завенягиным в КБ-11 передайте тт. Харитону, Щёлкину, Духову, Тамму, Сахарову, Зельдовичу, Забабахину и Боголюбову, что нам надо приложить все усилия к тому, чтобы обеспечить успешное завершение научно-исследовательских и опытно-конструкторских работ, связанных с РДС-6С.

Передайте это также и тт. Ландау и Тихонову.

3. Ознакомить т. Ванникова Б.Л. (по возвращении на работу).

Л. Берия

2 декабря 1952г.



Konstantin Adolfovich Semendyaev

(1908-1988),

mathematician, major specialist in the field of computational mathematics,

active participant in the development of the first atomic and thermonuclear charges, worked on the Atomic and Thermonuclear projects at the Mathematical Institute of the USSR Academy of Sciences (1946-1964), three-time winner of the State Prize (photo - www.ershov.ras.ru)

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"On the use of the hydrogen bomb"

Under this headline, the New York World Telegram and Sun carried an article by its correspondent Douglas Larsen on November 26, 1952: "Some senior Pentagon officials are only now admitting how stunned they are by the full significance of the recent tests at Eniwetak Atoll, which proved that hydrogen bomb[3] can be blown up."[4]

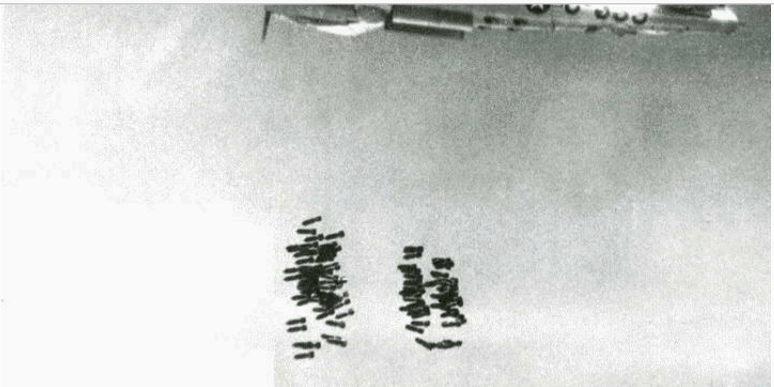
***

In the development of the RDS-6s, mathematical modeling was extremely important. The main mathematical calculations for RDS-6s were carried out in Moscow in teams led by A.N. Tikhonov, K.A. Semendyaev and L.D. Landau.

Since April 1953, these works were concentrated in the specially formed Department of Applied Mathematics of the Mathematical Institute of the USSR Academy of Sciences, which was headed by M.V. Keldysh. In KB-11, calculations were carried out by teams of mathematicians under the leadership of N.N. Bogolyubov and V.S. Vladimirova.

The RDS-6s test took place on August 12, 1953 at the Semipalatinsk test site. It became the fourth in a series of nuclear tests launched by the USSR on August 29, 1949. The energy release of RDS-6s was equivalent to the energy of the explosion of 400,000 tons of TNT.

Work on RDS-6s continued. On November 6, 1955, the USSR successfully tested the RDS-27 charge, which was a modernization of the RDS-6s based on the use exclusively of lithium deuteride (without the use of tritium). At the same time, the parameters of the heterogeneous core were somewhat modernized. The energy release of the charge was 250 kt, which is 1.6 times less than the energy release of the RDS-6s, but significantly exceeded the energy release of traditional nuclear charges. In terms of its design qualities, it was a real weapon; it was tested as part of an aerial bomb dropped from an airplane.



Korean War. American B-29 bomber strikes industrial facilities

Construction of a high-rise building. Moscow, 50s

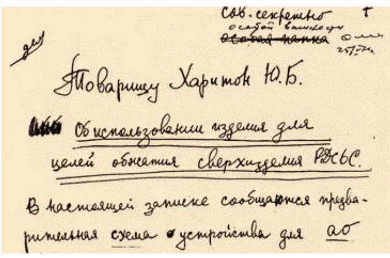
5. FUNDAMENTAL IDEAS THAT LEAD TO THE DEVELOPMENT OF RDS-37

Work on the RDS-6s created a scientific and technical basis, which was then used in the development of a fundamentally new type of hydrogen bomb - a hydrogen bomb based on the principle of radiation implosion. It is significant that both during the development of RDS-6s and during the development of RDS-37, data on the characteristics of thermonuclear reactions and neutron-nuclear interactions were important. For these purposes, extensive research was launched with the involvement of many academic and industrial institutions. The scale of the nuclear physics research being carried out is illustrated by the work program formulated in KB-11 at the beginning of 1951 (see Appendix 4). Although a significant part of the work was carried out within the framework of the development program for the RDS-6s, as well as the RDS-6t, their results directly formed the basis for the development of the RDS-37.

The achievement of a large energy release in RDS-6s stimulated hopes for the creation of a megaton-class thermonuclear charge (up to 2 Mt) within the framework of this principle. The difficulties along this path were great. They were associated both with the impossibility of increasing the weight and size parameters of the charge (limited by the capabilities of the delivery vehicles), and with the need to exclude significant amounts of tritium from the charge scheme. However, the new RDS-6SD project at the end of 1953 became the main direction of the USSR thermonuclear program. It was led by Academician A.D. Sakharov. The problematic nature of solving the problem along this path stimulated the development of other directions.

The history of work on a new physical principle for the design of thermonuclear weapons in the USSR and the creation of the first thermonuclear bomb on this principle, which received the designation RDS-37, is full of drama.

The new principle made its way into life in the process of intensive work in other areas of research and design of thermonuclear weapons, which were given priority. These directions were, as is clear from the previous presentation, research into a non-compressible cylindrical system with liquid deuterium, in which nuclear detonation of deuterium was expected to occur under the influence of a nuclear explosion, and the development of a powerful layered thermonuclear charge based on RDS-6s, compressible by the explosion of a chemical explosive.

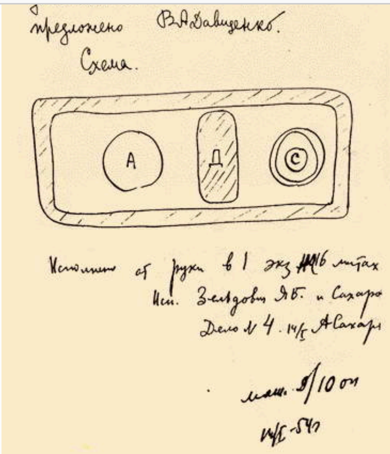


Сов. секретно
особой важности
~~Особая папка~~

Товарищу Харитон Ю.Б.

Об использовании изделия для целей обжатия сверхизделия РДС6С.

В настоящей записке сообщаются предварительная схема устройства для АО



Fragments of documents on gas-dynamic atomic compression, considered by Ya.B. Zeldovich and A.D. Sakharov in January 1954

In the early 50s, along with the idea of thermonuclear enhancement of the energy release of nuclear charges, another idea was discussed - the idea of the possibility of more efficient compression of nuclear material compared to the compression provided by the explosion of chemical explosives. Initially, this idea was formulated in general terms as the idea of using nuclear explosions of one or more charges to compress nuclear fuel located in a separate module, spatially separated from the primary source(s) of the nuclear explosion. The authors of this general idea, which can be called the idea of "nuclear implosion," are V.A. Davidenko, A.P. Zavenyagin and D.A. Frank-Kamenetsky. In January 1954 Ya.B. Zeldovich and A.D. Sakharov consider this scheme in detail / 7, p. 128/.

***

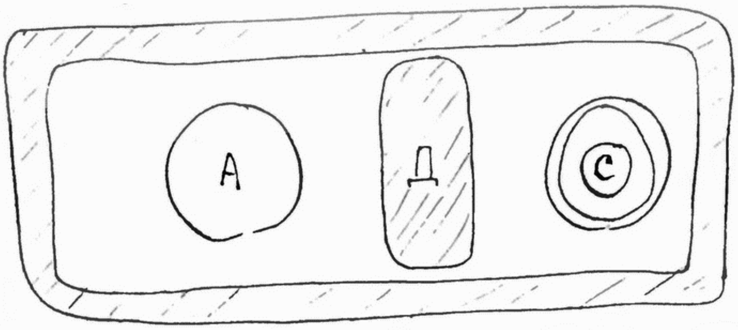
"Owl" secret of special importance

Comrade Khariton Yu. B.

On the use of the product for the purpose of crimping the superproduct RDS-6s

This note reports a preliminary design of a device for an AO superproduct and estimated calculations of its operation. The use of AO was proposed by V.A. Davidenko.

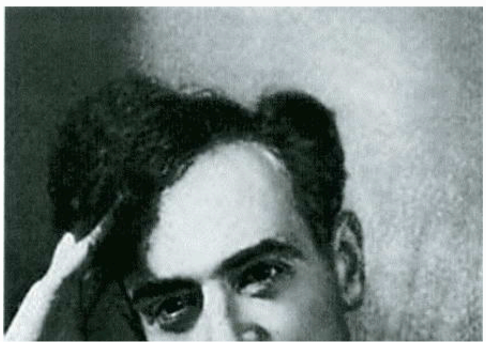
Scheme

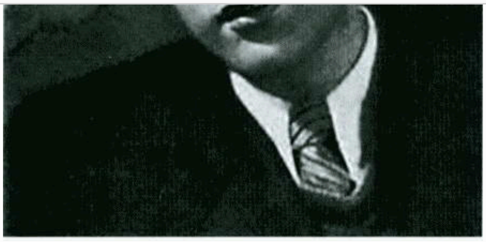


The proposed system consists of a metal body <...>, divided by a diaphragm D into two approximately equal volumes. The total weight of the structure is about 26-30 tons. <...> In one volume there is product A, in the other - product C. Products A and C are surrounded by boron fill. <...>

We do not consider the first period - the spread of energy through product A; in this period, at first, more than half of the energy is radiation energy and spreads through the mechanism of radiative thermal conduction, but by the end of the period a shock wave is already generated, the speed of which becomes greater than the speed of radiation diffusion. <...>"

Research into the energy processes of a nuclear explosion of primary sources (nuclear charges) was of fundamental importance. The peculiarity of the circuits of some of these charges was that the level of energy release realized in them was sufficient for the main part of the energy of a nuclear explosion to come out of the central region containing fissile materials in the form of x-rays and spread through the products of the explosion of chemical explosives. This feature of a nuclear explosion was studied back in 1947-1948. in the pioneering works of the group L.D. Landau.





Lev Davidovich Landau

(1908-1968),

outstanding physicist of the 20th century, academician, active participant in the Atomic and Thermonuclear projects (1945-1955), founder of the school of theoretical physics in the USSR, Hero of Socialist Labor, laureate of Lenin and three State Prizes, Nobel Prize laureate

David Albertovich Frank-Kamenetsky

(1910-1970),

an outstanding theoretical physicist, an active participant in the development of the first atomic and thermonuclear charges, founder of a scientific school, three-time winner of the State Prize, worked at KB-11 from 1947 to 1956.

***

This idea contains a fundamental idea of a two-stage nuclear charge. From the very beginning, a number of questions arose regarding the possibility of its implementation, which can be grouped into two groups.

The first group of questions related to the very concept of "nuclear implosion". The scheme of operation of a nuclear charge, well studied by that time, assumed the compression of nuclear (or nuclear and thermonuclear, as in RDS-6s) material by a spherical explosion of chemical explosives, in which the spherical symmetry of the implosion was determined by the initial spherically symmetrical detonation of the explosive. It was obvious that in a heterogeneous structure of a primary source (sources) and a compressed secondary module, similar initial possibilities for realizing a spherically symmetric "nuclear implosion" are absent. This question was closely related to another question: what is the carrier of the explosion energy of the primary source and how is this energy transfer to the secondary module carried out?

The second group of questions was related to what the secondary module, which is affected by nuclear implosion, should be.

It was initially assumed that the transfer of energy from a nuclear explosion of a primary source in a two-stage charge should be carried out by the flow of explosion products and the shock wave created by them, propagating in the heterogeneous structure of the charge. In January 1954, this approach was analyzed by Ya.B. Zeldovich and A.D. Sakharov. At the same time, it was decided to take as the basis for the physical design of the secondary module an analogue of the internal part of the RDS-6s charge, that is, a "layered" system of a spherical configuration. Thus, a specific idea of a two-stage charge based on the principle of hydrodynamic implosion was formulated.

It should be noted that this was an extremely complex system, in terms of the actual computing capabilities of the time. The main problem was how in such a charge it would be possible to ensure compression of the secondary module close to a spherically symmetrical regime, since the velocities of propagation of shock waves around the module and inside it did not differ too much.

After several months of work on this project, their results were transformed into a principle in which the energy transfer of the primary module was carried out by x-ray radiation, and to form the direction of energy transfer, the primary and secondary modules were enclosed in a single shell (as in the case of hydrodynamic implosion in the January 1954 project .), which had good quality for reflecting X-rays, and measures were provided inside the charge to facilitate the transfer of X-rays in the desired direction.

During this work, Yu.A. Trutnev proposed a method for concentrating the energy of X-ray radiation in material pressure, which made it possible to more effectively carry out radiation implosion. HELL. Sakharov describes the emergence of the idea of radiation implosion in KB-11 /8/: "Apparently, several employees of our theoretical departments simultaneously came to the "third idea". One of them was me. I think I understood the basic physics and mathematics of the "third idea" early on. Because of this, and also thanks to my previously acquired authority, my role in the acceptance and implementation of the "third idea" may have been one of the decisive ones. But also, undoubtedly, the

An important scientific and technical achievement was the creation of a primary atomic charge for the first two-stage thermonuclear charge RDS-37. During its development, in addition to ensuring the required level of energy release, it was important to create optimal conditions for the release of X-ray radiation into the volume occupied by the thermonuclear module. Another important task was associated with a significant reduction in the likelihood of predetonation, that is, the occurrence of neutron initiation of a chain reaction before the required time. These works were supervised by Ya.B. Zeldovich.

A significant role in the development of the principle of radiation implosion was played by D.A. Frank-Kamenetsky, who at the end of 1954, together with A.D. Sakharov issued a report that analyzed many of the scientific aspects of the new principle and the possibilities of its application to create various types of thermonuclear charges.

The body of a thermonuclear bomb in the Museum of Nuclear Weapons RFNC-VNIIEF. Many charges were tested in such a case, including RDS-6s and RDS-37

6. INITIAL STAGE OF RDS-37 DEVELOPMENT

PROBLEMS WITH THE DEVELOPMENT OF THE POWERFUL "Puff" RDS-6SD

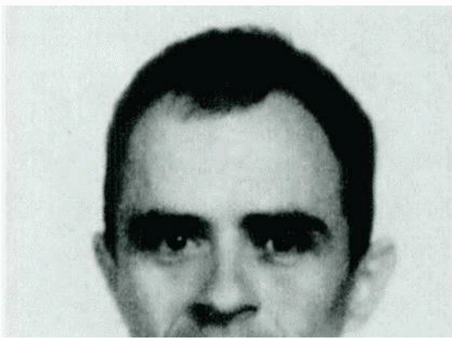
On July 16, 1954, a technical meeting was held with the participation of the Minister of MSM V.A. Malyshev, at which a report was heard from the management of KB-11 on the state of development of the powerful hydrogen bomb RDS-6SD - a full-scale layered thermonuclear charge. The meeting from KB-11 was attended by Alexandrov A.S., Khariton Yu.B., Lavrentiev M.A., Zababakhin E.I., Davidenko V.A., Negin E.A., Tsukerman V.A., Grechishnikov V.F., Popov N.A., Zysin Yu.A., Babaev Yu.N. and others. During the meeting, due to difficulties encountered in achieving the required level of energy release of the RDS-6SD, V.A. Malyshev emphasized the need to search for new principles in the development of atomic and hydrogen weapons that surpass the principles of RDS-6s.

At the meeting it was decided: "Currently, due to a lack of calculated data, it is not possible to make a final choice of the design option for the RDS-6 bomb with a capacity of 2 million tons in the dimensions of the RDS-6s. According to available approximate calculations, the most effective is the pure version of the SD-1 bomb.

KB-11 will develop the SD-1 bomb variant while maintaining the same production time for the RDS-6SD combat bomb for test site No. 2 (November-December 1954) with a capacity of 1 million tons" /7, p. 195/.

Within the framework of this topic, 8 options for the RDS-6SD were reviewed and discussed, but none of them met the requirements of the technical specifications /7, p.201/.

> Transmittal note from M.V. Keldysh to task No. 1 for calculating the heating of the wall (casing) of the product on the AO principle April 28, 1954
>
> Comrade N.I. Pavlov for Khariton /O. B.
>
> With this, I am sending you task No. 1 (Warming up the wall).
>
> Appendix: Mentioned on the 1st expanded sheet, No. 4594.4
>
> *M.V. Keldysh*



Nikolay Alexandrovich Dmitriev

(1924-2000),

theoretical physicist, active participant in the development of the first atomic and thermonuclear charges, one of the founders of modern physical and mathematical methods for calculating nuclear charges, winner of two State Prizes, worked at KB-11 from 1948 to 2000.

RADIATION IMPLOSION

One of the fundamental points in a charge based on the principle of radiation implosion is the question of the interaction of X-ray radiation propagating inside the charge with structural elements made of heavy metals. In April 1954 G.M. Gandelman and N.A. Dmitriev release technical specifications (the first official document) to calculate the heating of a wall made of heavy material by X-ray radiation.

In a letter to A.S. Alexandrova, Yu.B. Khariton, K.I. Shchelkina, A.D. Sakharova, Ya.B. Zeldovich, addressed to V.A. Malyshev on June 24, 1954, for the first time there is a mention of the possibility of creating hydrogen bombs based on atomic compression / 7, p. 174/: "As a result of the consideration, the fundamental possibility of creating transportable, very powerful and extremely economical products based on atomic compression with a high lithium-6 content was revealed <...> It should be emphasized that for JSC products we currently do not have a final design of the product, nor any precise calculations."

A detailed research plan on the principle of atomic compression is contained in the report on the work of sector No. 1 KB-11 for the first half of 1954, signed by A.D. Sakharov and Yu.A. Romanov (06.08.1954) /7, p. 230/:

"IV<… > Atomic compression.

Theoretical research on atomic compression is carried out jointly with employees of sector No. 2.

Report by A.D. Sakharov and D.A. Frank-Kamenetsky

"Atomic compression"

December 9, 1954

I. Operating principle

The atomic compression system (abbreviated AO) consists of the following main design elements (see diagram 1).

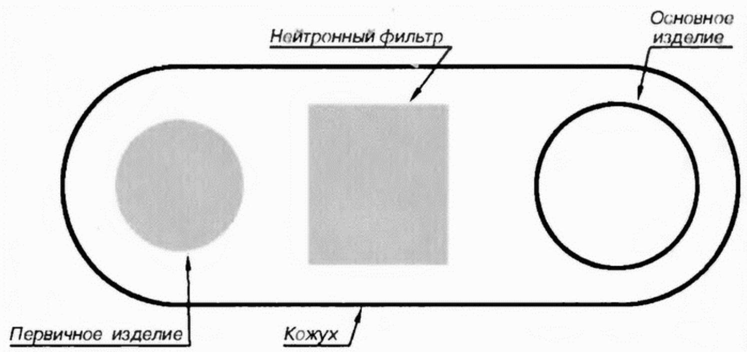


Схема № 1

<…> Using atomic compression, it is in principle possible to compress tens and even hundreds of kg of light matter inside a heavy shell to a density tens of times greater than its initial density, which makes it possible to cause a thermonuclear explosion in a light matter with a high utilization rate. <…>

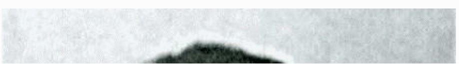
II. Additional structural elements

In addition to the main structural elements described above, additional structural elements can be introduced into the design, the need for which has not currently been proven. The issue of introducing these elements into the design will be decided after calculations and experiments. <…>

III. Expected System Performance

According to preliminary estimates, it is fundamentally possible to create an AO system with the following indicative characteristics. Total weight is about 15 tons. <...> When a light substance is burned, <...>% energy is released equal to 7.5 megatons of fuel emission. <…>

Creating a technically advanced AO system in a size significantly smaller than 15 tons is probably a more complex, but also feasible task. The creation of a technically advanced AO system with a size of 15 tons should be preceded by experience with a more primitive system that tests the basic physical principles of AO and does not require lengthy theoretical work for its preparation.



Grigory Mikhailovich Gandelman (1920-1993),

theoretical physicist, active participant in the development of the first atomic and thermonuclear charges, winner of two State Prizes, worked at KB-11 from 1948 to 1970.

The main issues related to atomic compression are under development.

1. The output of radiation from the atomic <...> radiation comes out

very good <…>.

2. Conversion of radiation energy into energy compressing the main object. Offered <…>.

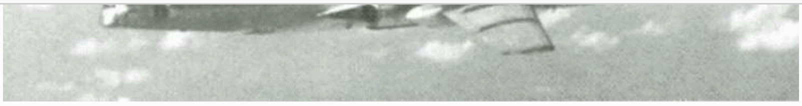
These principles were developed as a result of the collective work of sectors No. 2 and 1 (Zeldovich, Trutnev, Sakharov). A series of calculations were carried out on the interaction of radiation with the casing of the product and on the passage of radiation from the initiating product inside the casing.

3. Compression of the main object. A series of compression calculations are carried out under different assumptions about the product design.

4. Theory of efficiency of atomically compressed systems <…>.

5. Initiation during atomic compression <…>".

On December 8, 1954, A.D. Sakharov and D.A. Frank-Kamenetsky release the report "Atomic Compression" /7, p. 281/.



Tu-16 - aircraft carrying thermonuclear bombs

7. DEVELOPMENT OF RDS-37

By the end of 1954, research and development of the principle of the atomic environment had reached a level sufficient to transfer the issue to a practical level - the design and preparation for testing of a special device to test this principle. Since this development was not included in the plans of KB-11, this required a special decision of the minister, and then a decision of the Government.

Immediately before the arrival of Minister of MSM V.A. in December 1954 at KB-11. Malyshev, a work plan was drawn up on the problem of atomic compression, in which the stages of work and those responsible for it were defined in detail / 7, p. 282/.

Joint work plan on the problem of JSC sectors No. 1 (Ya.B. Zeldovich) and No. 2 (A.D. Sakharov)

"Leaders: 1) E.I. Zababakhin, 2) Ya.B. Zeldovich, 3) Yu.A. Romanov, 4) A.D. Sakharov, 5) D.A. Frank-Kamenetsky.

1. Development of a proof-of-principle model system through field testing.

Issue of technical specifications 02/01/55

Development of a measurement program 04/01/55

Calculation of expected power 07/01/55

Performers: Zababakhin, Frank-Kamenetsky, Feoktistov, Gandelman, Adamsky, Dmitriev, Trutnev, Rabinovich, Rodigin, Zagrafov, Romanov, Sakharov.

2. Development of a powerful AO system weighing 15 tons. Assignment for preliminary preliminary design of the first version by 04/01/55.

In case of a successful solution - a technical design assignment by 12/01/55.

Performers: Sakharov, Romanov, Shumaev, Kozlov, Babaev, Goncharov, Zagrafov, Kurilov, Gandelman, Adamsky.

3. Theory of compression and external thermal processes in systems

a) Heat penetration into the casing.

b) Symmetrization.

c) External hydrodynamics; mitigation.

d) Approximate calculation methods.

e) Analysis of exact calculations.

f) Improving the methodology for accurate calculations. Preliminary report 06/01/55

Calculations of design options and final report 12/01/55

Performers: Zababakhin, Popov, Vakhrameev, Adamsky, Klinishov, Gandelman, Zagrafov, Babaev.

4. Calculations of power and initiation of AO systems.

a) Study of the influence of various factors on the efficiency of combustion of light substances.

b) Dilute systems (introduction of beryllium or incompletely enriched lithium into nuclear fuel).

c) Calculation of the work of an initiator on a dilute heavy substance in the presence of a background.

d) Initiator with increased thermal conductivity (dilution with beryllium).

e) Calculation of the "bubble" type initiator.

e) Calculation of the thermonuclear initiator.

g) Theory of autocatalytic initiator. Preliminary report 03/01/55

Report on approximate methods 01.06.55 Calculations of design options 01.06 and 01.12.55 Performers: Feoktistov, Rabinovich, Trutnev, Frank-Kamenetsky, Romanov, Kozlov, Goncharov, Churazov.

5. Clarification of the equations of state and thermal conductivity characteristics of light and heavy substances.

Предварительный отчет 01.06.55 г. Окончательный отчет 31.12.55 г. Исполнители: Рабинович, Кузнецова, Климов, Александров, Обухов, Романов.

6. Изучение прохождения нейтронов через изделие и фильтр, участие в модельных опытах.

7. Расчеты несимметрии, неустойчивости и перемешивания.

Отчет к 01.12.55 г.

Исполнители: Бабаев, Дворовенко, Дмитриев, Сахаров».

* * *

Протокол расширенного заседания научно-технического совета КБ-11

24-25 декабря 1954 г.

«Присутствовали: тт. Курчатов И.В. (председатель НТС), Харитон Ю.Б. (зам. председателя НТС), Александров А. С., Алферов В. И., Альтшулер Л. В., Бессарабенко А. К., Боболев В. К., Галин Л. А., Гречишников В. Ф., Давиденко В. А., Духов Н. Л., Забабахин Е. И., Замятиин Ю. С., Захаренков А. Д., Зельдович Я. Б., Зернов П. М., Зысин Ю. А., Кочарянц С. Г., Лаврентьев М. А., НегинЕ.А., Некруткин В. М., Попов Н. А., Петров Н. А., Романов Ю. А., Сахаров А. Д., Терлецкий Н. А., Франк-Каменецкий Д. А., Цукерман В. А., Цырков Г. А., Шатилов В. Ф., Силкин А. С., Тамм И. Е., Зуевский В.А. и Бриш А. А.

В работе НТС принял участие министр среднего машиностроения т. Малышев В.А. Научно-технический совет рассмотрел и обсудил планы опытно-конструкторских и научно-технических работ КБ-11 на 1955 г. Докладывал т. Харитон Ю. Б».

План опытно-конструкторских работ по созданию новых типов атомного и водородного оружия НТС рассматривал по каждому изделию в отдельности и принимал специальные решения.

Доклад о термоядерном заряде на новом физическом принципе сделал Я.Б. Зельдович.

В отношении создания РДС-37 было существенно, что НТС отметил: «Для разработки изделия АО необходимо провести в 1955 г. модельный опыт с целью проверки сферической симметрии сжатия излучением. В этом опыте также будет зафиксирован ход нейтронной реакции и мощность взрыва основного изделия (обжимаемого)».

В обсуждениях вопроса отмечалось следующее:

«В КБ-11 длительное время обсуждалась схема модельного опыта и цель его проведения (т. Харитон). Вначале предполагалось определить лишь интенсивность излучения обжимающего изделия. Затем была установлена необходимость в проведении опыта с моделью, подобной полной конструкции системы АО.

Проведение модельного опыта по результатам будет аналогично точному расчету (т. Франк-Каменецкий). Опыт с модельной системой необходим для проверки принципа обжатия излучением. В случае положительных результатов модельного опыта разработка мощных изделий на принципе атомного обжатия продвинется далеко вперед (т. Курчатов).

Теоретически модельная система продумана в достаточной степени и даны большие запасы. Вся система точному расчету не подвергалась, но отдельные узлы просчитаны с достаточной точностью (т. Сахаров). Тт. Малышев и Курчатов считают целесообразным обсудить проблему АО с ведущими физиками (Арцимовичем, Леонтовичем, Ландау, Померанчуком) с целью дополнительной проверки идей и расчетов.

Большому значению проблемы АО посвящают свои выступления Тамм, Сахаров, Духов, Курчатов.

В основе этого крупного шага, нового этапа в развитии ядерного оружия, лежит простая физическая идея — обжатие излучением. Идея и применяемые физические законы не должны вызывать сомнений (Тамм). Атомное обжатие позволит использовать для получения взрыва относительно дешевые активные вещества и значительно повысит КПД изделий (Сахаров). АО открывает широкую перспективу в разработке мощных изделий, тогда как возможности известных конструкций (слойки, НБУ) ограничены (Курчатов). Необходимость мощных изделий очевидна, но нам нужны габаритные и дешевые изделия (т. Малышев), которые можно носить не только на самолете. Для разработки проблемы АО нужен не только энтузиазм, нужны расчеты, критика идей — серьезная проверка принципов проблемы. При разработке конструкции следует учитывать, что литий в ближайшее время дешевым не будет. Модельная система АО, которую предлагается испытать в 1955 г., должна быть по возможности подобной конструкции будущей бомбы и включать максимум ее элементов. Разработку проблемы АО целесообразно из общего плана КБ-11 исключить, составить отдельный план с подробной пояснительной запиской и представить на рассмотрение Правительства.

Решение:

1. План разработки проблемы АО с подробной пояснительной запиской представить на утверждение в СМ СССР отдельно от общего плана работ КБ-11.

2. Разрешить проведение разработки модельной системы для опыта в 1955 г. до утверждения плана».

Из следующих этапов разработки РДС-37 отметим выпуск технического задания на разработку РДС-37. Техническое задание на конструирование РДС-40 (37), предназначенное для проверки научных принципов, положенных в основу изделий с атомным обжатием, было выпущено А.Д. Сахаровым, Д.А. Франк-Каменецким и Л.П. Феоктистовым 03.02.55 и направлено в адрес Ю.Б. Харитона. ТЗ составлено в достаточно общем виде (всего 2 страницы и схематический чертеж) /7, с. 307/.

Интересным является проект постановления СМ СССР от 1-2 февраля 1955 г. /7, с. 305/, подготовленный Ю.Б. Харитоном, А.Д. Сахаровым, Я.Б. Зельдовичем: «В целях ликвидации отставания в области создания мощного водородного оружия с малыми затратами тяжелых активных веществ Совет министров СССР постановляет:

1. Обязать Министерство среднего машиностроения:

а) провести в 1955 г. научно-исследовательские работы по разработке конструкции водородного оружия, основанной на принципе атомного обжатия легких веществ, лития-6 и дейтерия (см. план работ КБ-11 — Приложение № 12);

b) submit by July 1, 1955 to the Council of Ministers of the USSR considerations for conducting an experimental explosion to test the principle of atomic compression in 1955;

c) produce, before April 1, 1955, 6 kg of uranium-233 to equip experimental systems with atomic compression.

2. To oblige the USSR Academy of Sciences to carry out computational and theoretical work in the Department of Applied Mathematics (Academician Comrade Keldysh) (see the work plan of OPM Steklov Mathematical Institute - Appendix No. 22):

a) for a device intended for experimental testing of the principle of atomic compression (until 01.VII.55r.);

Performer Trutnev Yu.A.; mash. 9/36op. 27/155 g."

Already on February 16, the Presidium of the CPSU Central Committee approved the proposals of the MSM "on the development of a powerful hydrogen bomb based on the principle of encirclement," and on February 17, 1955, an order was issued by the Minister of MSM V.A. Malyshev on the development and testing of a new hydrogen bomb /7, p. 311/. February 24, 1955 D.A. Frank-Kamenetsky and G.M. Gandelman issued a report on the work on the AO problem for 1954, which quite fully sets out the results of calculations on the AO and the design scheme of the AO. March 3, 1955 A.D. Sakharov, Ya.B. Zeldovich, Yu.N. Babaev and L.P. Feoktistov was sent to the Steklov Mathematical Institute with a task to calculate the propagation of radiation in accordance with the RDS-37 drawing. At the same time, work was carried out to study various ways of developing the principle of radiation implosion and physical schemes of thermonuclear charges based on it. March 8, 1955 V.I. Ritus proposed an AO circuit with double compression /7, p. 331/.

It should be emphasized that in 1955, in addition to the development of the RDS-37, large-scale work was carried out in other areas. The work plan for 1955 determined the development of 5 nuclear charges and 8 nuclear weapons.

Note from V.I. Ritusa

"On some possibilities for using a small thermonuclear charge

For atomic compression of a large amount of light matter, it seems advisable to use a system consisting of an ordinary product and a small thermonuclear charge as a compression product, so that the entire system as a whole will look like in Fig. 11. <…>

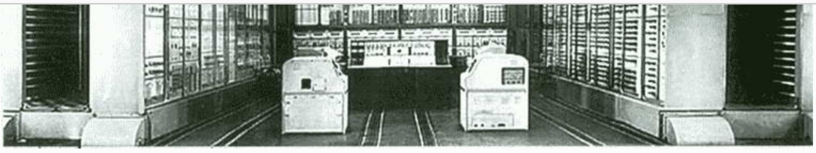
After the explosion "7" the AO of thermonuclear charges "2" and "3" occurs. <… >

Such pressure, which increases over time, leads, as is known, to significantly better compression of the product "3" than pressure that decreases over time.

Below are some calculations of the compression and efficiency of a specific small thermonuclear charge."

It should be emphasized that in 1955, in addition to the development of the RDS-37, large-scale work was carried out in other areas. The work plan for 1955 determined the development of 5 nuclear charges and 8 nuclear weapons.

Theoretical departments were located in the buildings of former monastery hotels in the 50s



The first electronic computer - "Strela" - appeared in OPM in 1954.

8. COMPLETION OF DEVELOPMENT OF RDS-37

May 26, 1955 Yu.B. Khariton, A.D. Sakharov, Ya.B. Zeldovich released in one copy “Proposal for testing an experimental device to test the principle of encirclement” / 7, p. 362/:

“The main task of the 1st half of the year, according to the plan, is to construct an experimental device to test the principle of encirclement. At present, the design of the device has been largely determined and basic data on the operation of the device are given. The expected explosion power is about 1 Mt, the accuracy is ± 40%, of which 40% is due to the combustion of U-235.

For the convenience of testing, the product is designed in the form of an aerial bomb in the size of an RDS-6SD and a similar weight (5570 kg).

Further theoretical work is expected to be carried out in the following directions:

a) design of a product with a capacity of 10-25 megatons (midsection diameter up to 2.3 m, weight up to 25 tons), size, weight, amount of active substance must be specified, based on the fact that the carrier is able to carry the load over a distance of about 8000 km;

b) designing a product in the size and weight of the RDS-6SD, which should differ from the proposed device in greater power and efficiency, as well as the possibility of using it in the head of the R-7 rocket.

During the design of the experimental device, the following work was done during January-May 1955:

1. The process of an atomic explosion and the release of energy in the form of radiation in two versions of the main charge of the primary product was calculated.

2. Thermal processes and expansion of the material of the casing walls when exposed to high temperature radiation are considered.

Formulas are given for the amount of evaporated substance, shock wave speed and other quantities depending on temperature and time.

To calculate the power of the explosion, the issue of the effective values of the neutron constants included in the calculation was reconsidered.

3. The process of nuclear reaction was calculated in several versions of the main products with different arrangements of layers and their different compression at the time of the onset of the nuclear reaction.”

On July 8, 1955, the report “Experimental device for testing the principle of environment (calculation and theoretical work)” was released, which is the final material for determining the characteristics of the main physical processes occurring in RDS-37, its physical parameters, including the predicted energy release / 7, With. 377/.

Here are a number of significant conclusions from this report.

“The introduction states that “the principle of encirclement has been developed in theoretical sectors since 1950.” At the beginning of 1954, the first successes were achieved, namely, the fundamental possibility of obtaining symmetrical compression of a hydrogen bomb (“main product”) due to radiant heat exchange of an additional (“primary”) product with a layer of light substance (“coating”) surrounding the main product was clarified.

In products using the environment principle, a number of processes play a critical role that have never been tested experimentally or studied theoretically.

1. Radiant heat transfer in a cavity of complex shape.

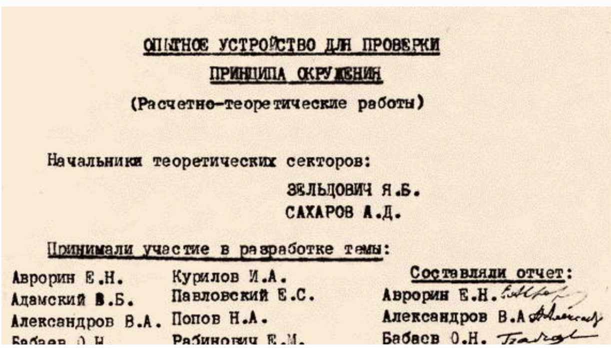
2. Heat penetration into the “coating” and into the “casing”, accompanied by expansion into a vacuum.

According to calculations, the proposed system is reliable. Its capacity is estimated to be in the range of 600-1400 thousand tons.

The development of the principle of environment is one of the striking examples of collective creativity. Some gave ideas (a lot of ideas were required, and some of them were independently put forward by several authors). Others differed more in developing methods of calculation and clarifying the meaning of various physical processes.

In the long list of development participants given on the title page, everyone’s role turned out to be significant.

In discussing the problem of encirclement at an early stage (1952), the participation of V.A. Davidenko was very fruitful.

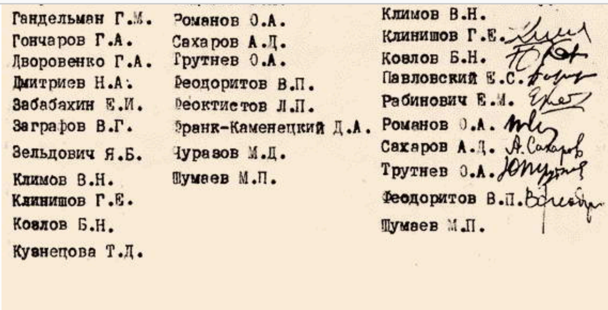


ОПЫТНОЕ УСТРОЙСТВО ДЛЯ ПРОВЕРКИ
ПРИНЦИПА ОКРУЖЕНИЯ
(Расчетно-теоретические работы)

Начальники теоретических секторов:
ЗЕЛЬДОВИЧ Я.Б.
САХАРОВ А.Д.

Принимали участие в разработке темы:

Аврорин Е.Н.	Курилов И.А.	Составляли отчет:
Адамский В.Б.	Павловский Е.С.	Аврорин Е.Н.
Александров В.А.	Попов Н.А.	Александров В.А.
Бабаев Ю.Н.	Рабинович Е.М.	Бабаев Ю.Н.



Гандельман Г.М.
Гончаров Г.А.
Дворовенко Г.А.
Дмитриев Н.А.
Забабахин Е.И.
Заграфов В.Г.
Зельдович Я.Б.
Климов В.Н.
Клинишов Г.Е.
Козлов Б.Н.
Кузнецова Т.Д.

Романов Ю.А.
Сахаров А.Д.
Трутнев Ю.А.
Феодоритов В.П.
Феоктистов Л.П.
Франк-Каменецкий Д.А.
Чуразов М.Д.
Шумаев М.П.

Климов В.Н.
Клинишов Г.Е.
Козлов Б.Н.
Павловский Е.С.
Рабинович Е.М.
Романов Ю.А.
Сахаров А.Д. А. Сахаров
Трутнев Ю.А.
Феодоритов В.П.
Шумаев М.П.

In the development of such a complex system, the role of mathematical calculations is especially important. In a number of cases, calculations of partial differential equations radically corrected our ideas about the operation of a particular unit or the role of a particular change in the system. These calculations were carried out mainly in the Department of Applied Mathematics of the USSR Steklov Mathematical Institute under the general supervision of M.V. Keldysh. and Tikhonova A.N.

1. Calculations of compression of the main product were carried out in the OPM in the department of Semendyaev K.A. A number of calculations were carried out in KB-11 in the department of Adamskaya I.A. Separate calculations were carried out in the department of Samarsky A.A.

2. Heat transfer calculations were carried out in OPM, department of Gelfand I.M.

3. Calculations of the efficiency of the primary product were carried out in OPM, department of A. A. Samarsky.

4. Calculations of heat penetration were carried out in OPM, in the department of Samarsky A.A.

5. Calculations of the explosion efficiency of the main product were carried out in OPM, in the department of Samarsky A.A. A number of calculations were carried out by I. M. Khalatnikov's group.

6. The calculation of the equations of state was carried out by I. M. Khalatnikov's group.

Many calculations were carried out on the OPM Strela electronic machine. Very complex problems of developing methods of calculation, programming and organization were solved.

The development of the experimental device required extensive design, experimental and technological work, carried out under the leadership of the chief designer of KB-11, Yu. B. Khariton.

Fishman D. A., Terletsky N. A., Yuryev B. A., Grechishnikov V. F., Matveev G. I., Bronnikov N. V., Koblov P. I., Kocharyants S. took an active part in the design work . G., Alekseev V. G., Dodonov P. P., Bogoslovsky I. V., Yanov A. I.

E. A. Feoktistova and B. A. Terletskaya took part in the development of lenses for the primary product.

Zakharenkov A.D., Kazachenko N.A., Kustov V.S., Ivanov A.G., Tarasov D.M., Litvinov B.V. took part in the gas-dynamic experiments.

V. A. Davidenko, B. D. Stsiborsky, A. A. Malinkin, G. P. Antropov are taking part in the experiments currently underway on the passage of neutrons in the product model.

Under the leadership of D.A. Fishman, G.A. Sosnina developed a beryllium shell design consisting of 240 three-group prisms with spherical bases, at the corner joints of which 110 truncated cones were placed. (beryllium was obtained in Podolsk (June 1955), and "parquet" was manufactured at plant No. 1 KB-1).

The development of focusing elements was carried out by department 22 of sector 3 (E.A. Feoktistova, B.P. Terletsky, Yu.A. Kosachanov) in June-September 1955.

In September 1955 L.M. Timonin, V.M. Gerasimov, I.G. Proskurin measured the speed of shock waves in the primary product on a model assembly.

The processes of casing destruction were studied (N.A. Kazachenko, V.S. Kustov, A.G. Ivanov, A.R. Oleinik).

The creation of first-generation thermonuclear charges was associated with solving a number of complex technological problems in the manufacture of charge parts from special materials. As an example, by 1955, the KB-11 pilot plant had mastered the technology of low-temperature pressing of parts in precision molds, but the quality of parts in terms of plasticity and density variations required significant improvement.

By the end of the 50s, a unique technology of "hot" pressing was created at temperatures of the original product close to melting. The density of parts was increased almost to crystalline, and the variation in density was reduced to several percent. The "hot" pressing technology subsequently ensured the production of a large range of parts with high quality density.

The development of technology was under the constant attention of Yu.B. Khariton, B.G. Muzrukov and the designers of KB-11. A great contribution to the creation of this unique technology was made by V.V. Kotov, V.N. Nikolaev, G.G. Savkin, N.G. Shelaton.

In explosive experiments on X-ray photography of dynamic processes, X-ray tubes developed under the direction of V.A. were used. Tsukerman and D.M. Tarasova.

To determine the level of validity of the development of a thermonuclear charge based on a new physical principle and the fundamental possibility of testing its operation in a full-scale test, a commission of outstanding scientists consisting of I.E. worked in KB-11. Tamma (chairman), M.V. Keldysh, M.A. Leontovich, A.D. Sakharova, V.L. Ginzburg, Ya.B. Zeldovich, I.M. Khalatnikov, who got acquainted with the theoretical and experimental work on product 37. At the commission meetings, reports were heard from Sakharov, Zeldovich, Trutnev, Shumaev, Romanov, Babaev, Rabinovich, Gandelman, Kozlov, Alexandrov, Feodoritov, Stsiborsky, Zamyatin, Ledenev and Tarasov and in detail problems related to the operation of individual components of product 37 were discussed. The commission also became familiar with the reports of theoretical sectors No. 1 and 2, containing a physical justification for the principle of atomic compression, a presentation of calculation methods and calculation results for this product.

From the conclusion of the commission I.E. Tamm dated July 01, 1955/7, p.371/:

"The Commission notes that KB-11 and OPM have done a lot of work to study new physical principles underlying the design of hydrogen

These studies show the possibility of creating hydrogen bombs with high power in limited dimensions and with significantly lower costs of active substances compared to the costs of existing products.

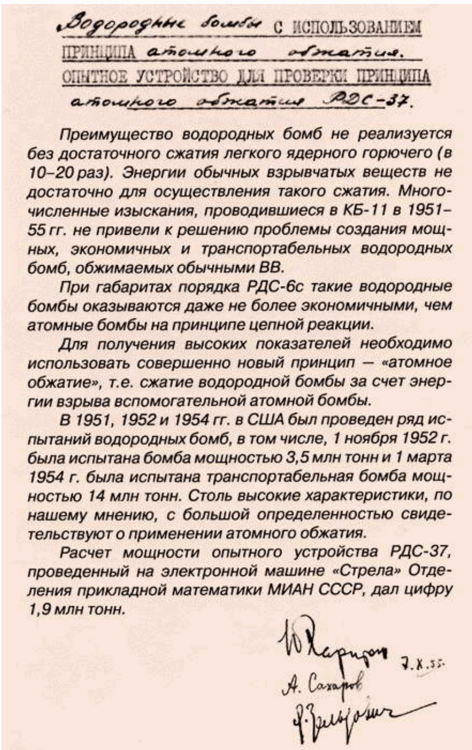
The commission believes that the next most important stage in the development of hydrogen weapons is the testing of the experimental device proposed by KB-11 at testing ground No. 2.

The work performed confirms the feasibility of conducting this test in 1955.

The commission recommends clarifying a number of nuclear principles with additional calculations and experiments listed above.”

Yuri Alexandrovich Romanov

(b. 1926), theoretical physicist, leading developer of the first thermonuclear charges, scientific director of the industry's work on missile defense and air defense, first deputy scientific director of VNIITF (1960-1967), deputy scientific director of VNIIEF since 1967, Hero of Socialist Labor , winner of the Lenin and two State Prizes, worked at KB-11 since 1950, at NII 1011 (VNIITF) - since 1955.



Водородные бомбы с использованием принципа атомного обжатия.
Опытное устройство для проверки принципа атомного обжатия РДС-37.

Преимущество водородных бомб не реализуется без достаточного сжатия легкого ядерного горючего (в 10–20 раз). Энергии обычных взрывчатых веществ не достаточно для осуществления такого сжатия. Многочисленные изыскания, проводившиеся в КБ-11 в 1951–55 гг. не привели к решению проблемы создания мощных, экономичных и транспортабельных водородных бомб, обжимаемых обычными ВВ.

При габаритах порядка РДС-6с такие водородные бомбы оказываются даже не более экономичными, чем атомные бомбы на принципе цепной реакции.

Для получения высоких показателей необходимо использовать совершенно новый принцип — «атомное обжатие», т.е. сжатие водородной бомбы за счет энергии взрыва вспомогательной атомной бомбы.

В 1951, 1952 и 1954 гг. в США был проведен ряд испытаний водородных бомб, в том числе, 1 ноября 1952 г. была испытана бомба мощностью 3,5 млн тонн и 1 марта 1954 г. была испытана транспортабельная бомба мощностью 14 млн тонн. Столь высокие характеристики, по нашему мнению, с большой определенностью свидетельствуют о применении атомного обжатия.

Расчет мощности опытного устройства РДС-37, проведенный на электронной машине «Стрела» Отделения прикладной математики МИАН СССР, дал цифру 1,9 млн тонн.

Ю. Харитон 7.X.55.
А. Сахаров
Я. Зельдович

Confidence in the reliability of the design of the first two-stage thermonuclear charge in 1955 was so great that, in the interests of test safety, the power of the thermonuclear explosion was specially reduced by half.

On September 26, 1955, Yu.A. Romanov released a report “State of calculation and theoretical work on the experimental device RDS-40 (RDS-37),” which analyzes the influence of various physical effects on the power of the product.

October 7, 1955 Yu.B. Khariton, A.D. Sakharov, Ya.B. Zeldovich released a report “Hydrogen bombs using the principle of atomic compression. Experimental device for testing the principle” /7, p. 397/.

It should be noted that the product design presented in the theoretical report at the end of June 1955 differs from that tested on November 22, 1955.

Changes were introduced right up to dispatch to the test site. In particular, the final choice of elements of the primary node was made only after conducting Crit-mass experiments.

One of the interesting questions is how ideas arose about the basic elements of the RDS-37 thermonuclear unit design - the first two-stage thermonuclear charge based on the principle of implosion. In terms of its structural type, this node is similar to the heterogeneous core of RDS-6c, adjusted for significantly different boundary conditions that determine implosion. It can be noted that the RDS-6s left a number of important ideas as the "legacy" of the RDS-37:

• spherical configuration of the thermonuclear unit;

• layered structure of fuel from lithium-6 deuteride and uranium-238;

• uranium initiating nucleus /1/. Energy release amplification factor in RDS-37

was about two orders of magnitude, the charge did not use tritium, the thermonuclear fuel was lithium deuteride, and the main fissile material was U-238.

The energy release of the charge in the experiment was 1.6 Mt, and since, for reasons of public safety at the Semipalatinsk test site, the charge was tested at partial power, the predicted full-scale energy release of the charge was 3 Mt (this is also a bold scientific step).

Testers' hotel at the Semipalatinsk test site

In preparation for testing the RDS-37, buildings were erected at the test site and equipment was placed to determine the extent of the impact of the explosion

9. PREPARATION FOR TESTS 1955

From the very beginning, the RDS-37 was designed as an aviation munition for promising new generation aircraft and ballistic missiles, so it was decided to test it by dropping it from a Tu-16 aircraft. The conditions for the air blast were also dictated by the requirements to ensure the safety of the population during testing. In 1955, the nuclear testing program at the Semipalatinsk test site consisted of 5 explosions, including two powerful air explosions: RDS-27 (November 6, 1955) with a power of 250 kTFC and RDS-37 (November 22, 1955) with a power of 1600 kTFC /3/.

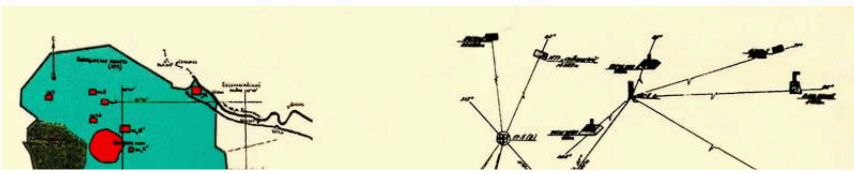
Previously carried out in 1949, 1951, 1953. at the Semipalatinsk test site, ground explosions were accompanied by serious contamination of the territory of Kazakhstan and the Altai Territory outside the test site (radioactive traces stretched mainly in the southeast direction - the predominant wind direction in the autumn).

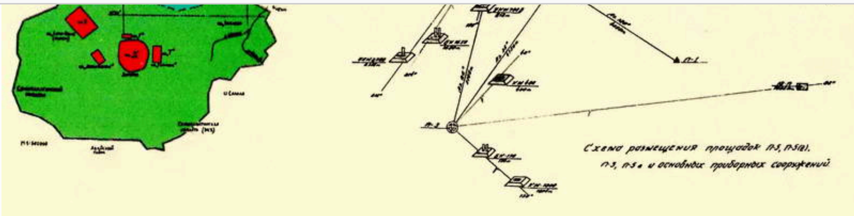
At the suggestion of Ministry of Defense specialists, by the beginning of 1955, the territory of the test site was expanded. However, this did not solve the problem of ensuring the safety of the population, so strict restrictions were introduced on the sector (only 25°), within which the spread of radioactivity was allowed.

To test high-power charges, a new site P-5 was equipped, the center of which was located five kilometers north of the center of the experimental field. For physical measurements, special underground casemates were built at distances of 700 and 1500 m from the center of P-5. Remote control of devices was carried out for the first time using a denser (8 times) information transmission system. The test management (I.V. Kurchatov) was located at the command post combined with aviation in the scientific town of the test site.

To monitor compliance with the requirements for ensuring the safety of the population, a representative of the Third Main Directorate of the USSR Ministry of Health was appointed to the State Commission for Testing.

In the mid-50s, the Semipalatinsk test site turned into a powerful research and testing center of the country for testing nuclear weapons of various classes and studying the damaging effects of a nuclear explosion. There was rapid construction of scientific buildings and a town located on the banks of the Irtysh. Three-story houses began to be built and gardens were laid out. The test town of the Semipalatinsk test site was recognized as the best military town in our country.





Scheme of training site No. 2 of the USSR Ministry of Defense (Semipalatinsk test site)

View of the test town of the Semipalatinsk test site. 1950s

June 20, 1955 B.G. Muzrukov, Yu.B. Khariton, A.D. Sakharov, Ya.B. Zeldovich send a letter to the new Minister of MSM with proposals for "testing an experimental device RDS-37"/7, p. 367/:

"To Comrade Zavenyagin A.P.

In accordance with Order No. 120 of February 17, 1955, we present proposals for testing the RDS-37 experimental device. The test must be carried out on a device whose description and operating principle are set out in report 2/248-OP. The prototype device will contain <...> kg U-233 and <...> kg U-235 <...>% in the primary product, <...> kg lithium-six deuteride and <...> kg U-238 <...> in the primary product. The expected power of the experimental explosion is 600-1400 thousand tons. To avoid the formation of a radioactive trace, the explosion must be carried out in the air at an altitude of 1-1.5 km.

To ensure an explosion in the air, the device is designed in the form of an RDS-6s aerial bomb. The test is proposed to be carried out in October 1955 at test site No. 2. During the test, the power of the explosion should be measured by the fireball, <...> and sampling by aircraft for the purposes of radiochemical research should be ensured."

On October 5, 1955, the leadership of the MSM and the Defense Ministry presented a draft Resolution of the USSR Council of Ministers "On testing of RDS products," and three days later, on October 8, 1955, Resolution of the Council of Ministers No. 1808-967ss "On testing of RDS products" was issued.

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From a letter from A.P. Zavenyagina, V.D. Sokolovsky, I.V. Kurchatova and Yu.B. Khariton to the Presidium of the CPSU Central Committee with the presentation of the draft Resolution of the USSR Council of Ministers "On testing RDS products"

October 5, 1955

"In accordance with the Resolution of the CPSU Central Committee of February 16, 1955, the Ministry of Medium Engineering organized in KB-11 the development of a new type of hydrogen bomb using atomic compression with a power of 1.0 to 2.0 million tons. By October 15th. In KB-11, a model of a new hydrogen bomb (RDS-37) will be manufactured, and in the second half of October it will be possible to test it at testing ground No. 2 of the Ministry of Defense.

In a hydrogen bomb with atomic compression, completely new processes are used, which until recently, for this purpose, were not considered in physics. Therefore, the RDS-37 product with atomic compression should be considered experimental. Physicists have carefully studied the phenomena that will occur during the explosion of this product, carried out large and very complex calculations, carried out a large amount of experimental work, and one can count on achieving successful results during testing.

However, due to the novelty of the processes underlying the design of the RDS-37 product, it is possible that some phenomena were not taken into account or were not sufficiently assessed, and therefore the success of the test is not guaranteed.

The idea of creating a hydrogen bomb on the principle of using the light energy of an atomic bomb explosion to compress the fissile materials of a hydrogen bomb belongs to Corresponding Member of the Academy of Sciences Zeldovich and Academician Sakharov, under whose leadership the theory of the process of explosion of a new hydrogen bomb was created.

Research and creation of the design of a hydrogen bomb with atomic compression was carried out at KB-11 under the leadership of Academician Khariton by a large team of KB-11 scientists and engineers; mathematical calculations were carried out at the Mathematical Institute of the USSR Academy of Sciences under the guidance of Academician Keldysh, corresponding members of the Academy of Sciences Tikhonov, Gelfand and the head of the sector of the Mathematical Institute Semendyaev; the examination of the product was carried out by academicians Kurchatov, Tamm, Leontovich, Keldysh, corresponding member of the Academy of

RDS-37 product with atomic compression and the work performed by KB-11 on this product.

The significance of the atomic compression of a hydrogen bomb is that the efficiency of using the fissile substances of the bomb increases for bombs with a caliber of 1.5 meters in diameter by 6 times compared to bombs created earlier. It also opens up the possibility of producing other calibers of bombs with a yield 10-100 times greater than those tested so far.

We have no direct information that the process of atomic compression is known to the Americans. However, indirectly (based on the TNT equivalent of the products they tested in 1954) one can judge that this method may have been used by them. <…>

In order to avoid a very serious danger of the population in the area of the test site being affected by radioactive dust, we believe that the detonation of all listed products will have to be carried out in the air at an altitude of 1-2 km. During testing at this altitude, no serious radioactive contamination on the soil is expected. To protect the population from the danger of shock waves, it is proposed that the test be carried out in a favorable wind direction. However, even in populated areas at a distance of up to 200 kilometers, destruction of window glass cannot be ruled out, especially in the direction of the prevailing wind.

For this reason, partial resettlement and concentration of the population of threatened settlements in assembly points is expected. The draft resolution is attached."

Children of testers at the Semipalatinsk test site. October 1955

A special appendix approved a detailed “List of measures to ensure the safety of the population during testing at training ground No. 2 of the Moscow Region in 1955” /7, p. 407/, according to which the weather conditions under which tests can be carried out were strictly regulated.

Clause 15 of this resolution provided for the payment of compensation to the population in the event of evacuation at the rate of 100-200 rubles per person; provision was made for the provision of transport, provision of medical care and “advance delivery of glass in the amount of 5,000 m2 and 100 m2 of putty.”

Responsibility for ensuring the safety of the population in sensitive zones was assigned to the head of the landfill A.V. Enko, for safety during product assembly - to the head of KB-11 B.G. Muzrukova.

The work of 1954 by N.N. was very important for assessing radioactive contamination of the environment. Semenova, N.A. Dmitrieva, V.N. Rodigina, N.N. Emanuel “on summarizing data on radioactive contamination arising from RDS explosions at UP No. 2” /7, p. 386/. As a result of this generalization, N.N.’s assumption was proven. Semenov about the similarity of radioactive traces.

Loading the charge into the carrier aircraft, taking off with the bomb and exploding the RDS-37. November 22, 1955

10. TESTING RDS-37

As far as I can tell, their 1955 design, although it used the same principles as ours, was developed entirely independently by them.

developer of the first US nuclear and thermonuclear charges, Nobel Prize laureate

The leadership of the USSR Ministry of Defense took part in the preparation and conduct of the test of RDS-37 (led by I.V. Kurchatov): Deputy Minister of Defense A.M. Vasilevsky, M.I. Nedelin, V.A. Bolyatko, Deputy Chairman of the Council of Ministers of the USSR - Minister of MSM A.P. Zavenyagin with a large group of MSM leaders, heads of institutes where measurement methods were developed.

From KB-11, except Yu.B. Khariton, head of KB-11 B.G. Muzrukov, chief engineer N.A. Petrova, Ya.B. Zeldovich, A.D. Sakharov, experimental physicists, specialists in charge assembly and testing of the automation system, a large group of young theoretical physicists - developers of the RDS-37 - took part in the tests. A large group of outstanding mathematicians attended the tests: M.V. Keldysh, I.M. Gelfand, S.K. Godunov, V.F. Dyachenko, O.V. Dokutsievsky, A.A. Samarsky, A.N. Tikhonov.

Until the mid-50s, the leading role in measuring the characteristics of nuclear charges, primarily their power, belonged to the Institute of Chemical Physics, the Radium Institute, and the State Optical Institute. The study of the damaging effects of a nuclear explosion and research into the effectiveness of anti-nuclear defenses were carried out, as a rule, by specialists from the Ministry of Defense. The scientific supervisor of work at the Semipalatinsk test site since 1949 was the Deputy Director of the ICP M.A. Sadovsky.

The total explosion power values were measured using the fireball, minimum glow and pressure pulse techniques in the compression phase of the shock wave; the relative mean square error of the fireball techniques was less than 5%. The method is based on measurements of the dependence of the radius R of the region covered by the shock wave (fireball) on time.

The R dependence was “corrected” based on the results of tests in 1951 and 1953. specialists from KB-11 D.A. Frank-Kamenetsky and N.A. Popov. Measurements

shock wave front velocities were carried out by specialists from the Institute of Chemical Physics of the USSR Academy of Sciences and the test site.

The fireball method has been recognized as the main method for determining explosion energy.

To study thermonuclear reactions, the method of neutron indicators, which were placed inside the charge, was widely used. For the first time, such measurements were used when testing RDS-6s and RDS-27. The Radium Institute, KB-11, specialists from the UP-2 test site (military unit 52605) and TsNII-12 (military unit 51105) took part in their processing.

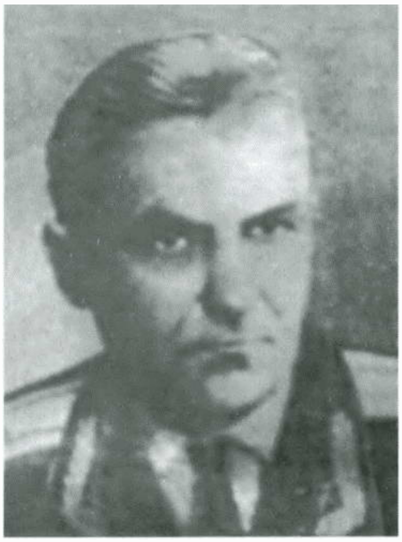
Due to the fact that a megaton-class charge was to be tested, special importance was attached to predicting the consequences of the damaging effect of the shock wave in the far zone. The degree of action of this factor depended on the vertical distribution of air temperature, wind direction and speed at different heights, as well as on other conditions. These assessments were carried out under the guidance of Academician S.A. Khristianovich.

General management of the aviation support for the tests was entrusted to Major General V.A. Black cutter. For the safety of the crew of the Tu-16 aircraft, OKB-167 MAP carried out special preparation of the aircraft for testing from October 25 to November 16, 1955, and to solve specific problems of ensuring the safety of the aircraft, a team of leading Tu-16 developers, scientists from VIAM, worked at the test site , Research Institute of PDS, Steklov Mathematical Institute (A.A. Arkhangelsky, A.V. Nadashkevich, A.A. Dorodnitsin, K.A. Semendyaev, etc.).

In the first half of 1955, 8 mock-ups of RDS-37 bombs were dropped (7 successful) to test the operation of the parachute system and the accuracy of the bombing. In order to increase the distance from the explosion site to the carrier aircraft and reduce the light pulse to an acceptable level, the management decided to equip the bomb with a parachute developed for the RDS-6s bomb at the Research Institute of Parachute Equipment. The MSM placed an order for parachutes on October 17, 1955, and on October 28, 1955 they were delivered to the Semipalatinsk training ground.

Three days before the test (originally scheduled for November 20), all representatives of the military command received instructions to begin educational work among the population of sensitive zones and to prepare buildings accordingly for the possible impact of a shock wave.

The bomb was prepared by KB-11 specialists and transferred for suspension to the aircraft at 6:45 a.m. on November 20, 1955, but due to the lack of visual visibility of the target and the failure of the radar bomber sight, the bombing did not take place. (The plane was equipped with two sights, radar and optical.) The plane with the bomb was allowed to land only after Ya.B. Zeldovich and A.D. Sakharov gave a written opinion on the safety of landing the plane with a charge, and Air Force specialists analyzed all emergency scenarios when landing the plane.



Fedor Pavlovich Golovashko,

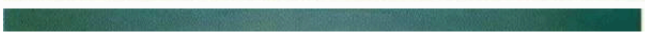
(1923-1980)

test pilot, Hero of the Soviet Union

The Semipalatinsk airfield had a limited runway for an aircraft with such a load (~ 5.5 tons), so it landed with parachute braking, having difficulty fitting into the runway. Subsequently, a strict decision was made to duplicate the tests with a second aircraft with a sight.

Crew commander—Major F.P. Golovashko, navigator—Major A.N. Kirilenko, second pilot - captain I.M. Romensky, navigator-radar operator - captain V.I. Lazarev, gunner-radio operator - Lieutenant B.I. Ozherelev, commander of firing installations - Sergeant Major N.P. Suslov.

At 9:47 a.m., targeted bombing was carried out from an altitude of 12 km at an aircraft speed of 985 km/h. The bomb was dropped over the P-5 test site. The explosion occurred at an altitude of 1550 m, at that moment the plane was 15 km from the explosion site (the heating of its skin reached 42-82 ° C).



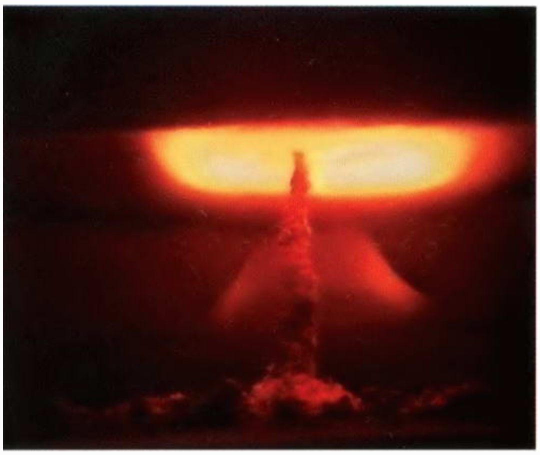
The results of aerial and ground radiation reconnaissance on the radioactive trace after the air explosion of RDS-37 clearly showed that the dose of external gamma radiation outside the test site was less than 0.3 R, therefore it can be stated that the population was not exposed to radiation exceeding dose limits.

At the epicenter of the explosion, after 2 hours, the gamma radiation dose rate did not exceed 1.5 R/h. The radius of the zone with $P < 0.5$ R/h was 800 m after 2 hours.

With the explosion of RDS-37, the influence of meteorological factors (temperature and velocity gradients in the atmosphere) was significantly revealed for the first time. On the day of the explosion, a temperature inversion was established (i.e., the air temperature rose with altitude). The wind speed also increased with height. Under such weather conditions, the pressure in the sound wave on the Earth's surface turned out to be 2-3 times greater than under standard weather conditions. The shock wave caused damage to buildings and glazing of buildings in 59 settlements (28 thousand m2 of glazing were destroyed at distances of up to 175 km).

One of the main results of the 1955 tests in terms of safety was the conclusion that the size of the Semipalatinsk test site precluded testing of powerful thermonuclear charges (for ground tests, the determining factor is the danger of radioactive contamination; for high-power air tests, the danger of damaging buildings). Based on the results of the 1955 tests, recommendations were adopted on the permissible power of explosions that could be carried out at the Semipalatinsk test site under various meteorological conditions. Since 1957, high-power charges, megaton class charges, began to be tested at the new nuclear

testing ground No. 700 of the USSR Ministry of Defense (Northern Test Site on Novaya Zemlya).



Summary materials on the test results of the RDS-37 product were signed by I.V. Kurchatov, Yu.B. Khariton, N.N. Semenov, A.D. Sakharov, Ya.B. Zeldovich, M.A. Sadovsky, A.V. Enko, B.M. Mamotov, I.N. Gureev.

By a resolution of the Council of Ministers of the USSR on the operation of atomic bombs and determining their power in 1955, a commission was formed, which included I.V. Kurchatov (chairman), Yu.B. Khariton, B.G. Muzrukov, N.I. Pavlov, E.A. Negin, V.A. Davidenko and others. V.A. was invited to the meeting of this commission to determine the explosion power of the RDS-37 bomb device. Bolyatko, A.V. Enko, B.M. Mamotov, B.A. Olisov, O.I. Leypunsky, V.Yu. Gavrilov, M.A. Sadovsky, G.I. Benetsky, I.N. Gureev, N.N. Semenov. The main report on the results of determining the TNT equivalent of the RDS-37 hydrogen bomb was presented by engineer-colonel I.N. Gureev, the energy release of RDS-37 was estimated at 1.6 Mt of TNT equivalent.

Having considered the results of the RDS-37 test at a meeting on November 24, 1955, the commission noted the following:

• the design of a hydrogen bomb based on a new principle was successfully tested;

• further detailed study of the processes occurring during the explosion of a bomb of this type is necessary;

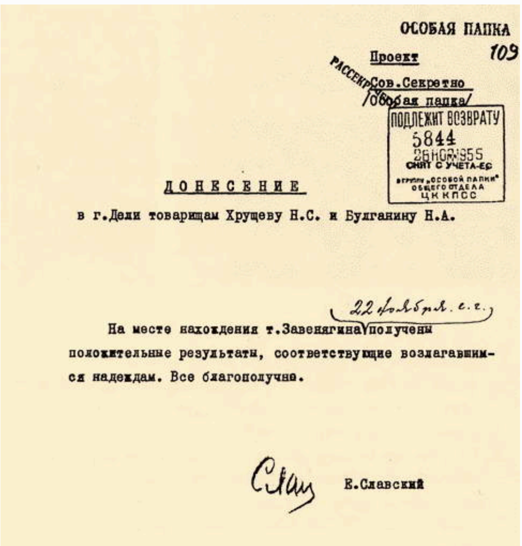
• further development of hydrogen bombs should be carried out on the basis of widespread use of the principles underlying the RDS-37 bomb.

During the testing days, the country's leadership was in India, and H.E. Slavsky prepared a telegram about the successful test of RDS-37/7, p. 419/:

"Report in Delhi to comrades N.S. Khrushchev. and Bulganin N.A.

At the location of Comrade Zavenyagin on November 22 this year. g. positive results were obtained that corresponded to the expectations. All is well.

E. Slavsky"



ОСОБАЯ ПАПКА

Проект 109

РАССЕКР Сов.Секретно

/Особая папка/

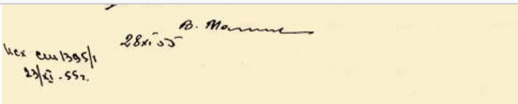
ПОДЛЕЖИТ ВОЗВРАТУ
5844
26 НОЯ 1955
СНЯТ С УЧЕТА-ЕС
в группы „особой папки" общего отдела ЦК КПСС

ДОНЕСЕНИЕ

в г.Дели товарищам Хрущеву Н.С. и Булганину Н.А.

На месте нахождения т.Завенягина 22 ноября с.г. получены положительные результаты, соответствующие возлагавшимся надеждам. Все благополучно.

Е.Славский



Telegram dated November 23, 1955 from the First Deputy Minister of Medium Engineering E.P. Slavsky to the First Secretary of the CPSU Central Committee N.S. Khrushchev and Chairman of the Council of Ministers of the USSR N.A. Bulganin about testing the RDS-37 product

In fact, immediately after the signing of the report on the results of the RDS-37 tests, an official statement appeared in the Pravda newspaper on November 27, 1955: “Recently, in accordance with the plan, research and experimental work in the field of atomic energy has been carried out in the Soviet Union testing new types of atomic and thermonuclear (hydrogen) weapons. The tests fully justified the relevant scientific and technical calculations, showing important new achievements of Soviet scientists and engineers. The last hydrogen bomb explosion was the most powerful of all the explosions carried out so far. In order to prevent radioactive effects, the explosion was carried out at a high altitude. At the same time, extensive research was carried out to protect people...

Due to the fact that in some Western countries there has been a fuss about the mentioned tests in the USSR, TASS is authorized to state the following:

The Soviet Government stood and stands for the prohibition of atomic and hydrogen weapons with the establishment of effective international control. Such a solution would make it possible to direct the use of nuclear energy exclusively for peaceful purposes. Proposals for an unconditional ban on atomic and hydrogen weapons were made by the Soviet Union both at the United Nations and at the recent meeting of the foreign ministers of the four powers in Geneva, but were not adopted. The Soviet Union also made a proposal for the moral and political condemnation of atomic and hydrogen weapons. The Western powers refused to accept this proposal as well.

While carrying out these tests in the interests of ensuring its security, the Soviet Union will continue to seek in the United Nations an agreement on the prohibition of atomic and hydrogen weapons and on the reduction of all other types of weapons, on the further reduction of international tension and the establishment of trust between states, on maintaining and strengthening universal peace."

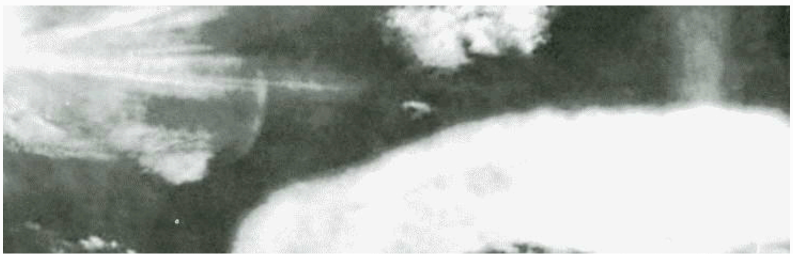
At the beginning of the journey, when the necessary knowledge was still lacking and the models were imperfect, a successful choice of the most stable physical system was required. This showed the talent of the RDS-37 developers, and nature responded to them in kind. Without this success, the future of our country in the harsh conditions of the nuclear confrontation of that time would have been a big question.

11. AFTER TESTING RDS-37

In the development of every science and technology there are turning points, high points, the emergence of new ideas, the implementation of radical leaps...

People grow with the work they do.

I WOULD. Zeldovich



AWARDS FOR THE CREATORS OF RDS-37

For the creation of the RDS-37, more than 2,400 people were awarded orders and medals of the USSR. I WOULD. Zeldovich was awarded the title of Hero of Socialist Labor for the third time, A.D. Sakharov - in the second. M.V. Keldysh, E.A. Negin, N.I. Pavlov became Heroes of Socialist Labor. Ya.B.Zeldovich, I.V.Kurchatov, A.D. Sakharov, Yu.B. Khariton, the first in the USSR, was awarded the Lenin Prize /7, p. 496/. Major F.P. Golovashko was awarded the title of Hero of the Soviet Union. The Order of Lenin was awarded to 88 people (of which 35 specialists from KB-11, 5 specialists from NII-1011).

It should be noted that the main developers of the RDS-37 from KB-11 were very young people at that time. They grew up in a specific job, became outstanding scientists who made a decisive contribution to the development of thermonuclear weapons in our country (in particular, 9 out of 31 theoretical physicists, developers of RDS-37, became Heroes of Socialist Labor at different times).

Resolution of the Council of Ministers of the USSR No. 1253-634

"On awarding the title of Lenin Prize laureate

scientists: vol. Zeldovich Ya. B., Sakharov A. D., Khariton Yu. B. and Kurchatov I.V."

Moscow, Kremlin, September 7, 1956

"Considering that the creation of a powerful hydrogen bomb based on a new physical principle is an outstanding achievement of Soviet science and technology,

Council of Ministers of the USSR

DECIDES:

1. For the development of physical principles and theoretical calculations of the RDS-37 product, the title of Lenin Prize laureate is awarded to:

Zeldovich Yakov Borisovich - corresponding member of the USSR Academy of Sciences, deputy scientific director of KB-11 of the Ministry of Medium Engineering;

Andrey Dmitrievich Sakharov - academician, deputy scientific director of KB-11 of the Ministry of Medium Engineering,

and give them a cash bonus in the amount of 75 thousand rubles each.

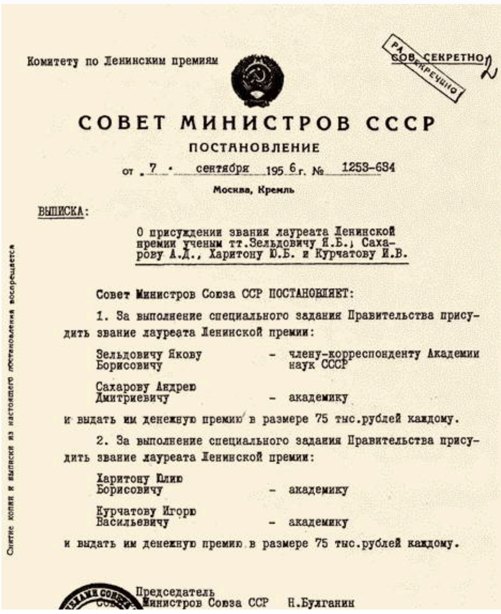
2. For the development of physical principles and nuclear physics research to create the RDS-27 and RDS-37 products, the title of Lenin Prize laureate is awarded to:

Khariton Yuliy Borisovich - academician, scientific supervisor and chief designer of KB-11 of the Ministry of Medium Engineering;

Kurchatov Igor Vasilievich - academician, chairman of the Scientific and Technical Council of the Ministry of Medium Engineering,

and give them a cash bonus in the amount of 75 thousand rubles each.

Chairman of the Council of Ministers of the USSR
N. Bulganin,
Administrator of the Council of Ministers of the USSR
A. Korobov"



Комитету по Ленинским премиям

СОВ. СЕКРЕТНО
РАССЕКРЕЧЕНО

2

СОВЕТ МИНИСТРОВ СССР

ПОСТАНОВЛЕНИЕ

от 7 сентября 1956 г. № 1253-634

Москва, Кремль

ВЫПИСКА:

О присуждении звания лауреата Ленинской премии ученым тт.Зельдовичу Я.Б., Сахарову А.Д., Харитону Ю.Б. и Курчатову И.В.

Совет Министров Союза ССР ПОСТАНОВЛЯЕТ:

1. За выполнение специального задания Правительства присудить звание лауреата Ленинской премии:

Зельдовичу Якову Борисовичу - члену-корреспонденту Академии наук СССР

Сахарову Андрею Дмитриевичу - академику

и выдать им денежную премию в размере 75 тыс.рублей каждому.

2. За выполнение специального задания Правительства присудить звание лауреата Ленинской премии:

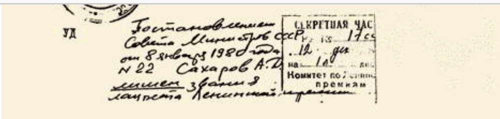
Харитону Юлию Борисовичу - академику

Курчатову Игорю Васильевичу - академику

и выдать им денежную премию в размере 75 тыс.рублей каждому.

Председатель Совета Министров Союза ССР Н.Булганин

Снятие копии и выписки из настоящего постановления воспрещается



In February 1956, Yu.B. Khariton sent a proposal to the MSM leadership to award the degree of Doctor of Technical Sciences without defending a dissertation to S.G. Kocharyants, E.A. Negin, V.F. Grechishnikov; academic degree of Candidate of Technical Sciences without defending a dissertation and passing candidate exams to N.A. Terletsky, P.A. Esin, D.A. Fishman, A.P. Gerasimov, G.D. Sokolov, A.S. Kozyrev, N.A. Smirnov, A.P. Pavlov, I.V. Alekseev, V.K. Livier, B.N. Ledenev, G.A. Tsyrkov, A.D. Zakharenkov, as well as candidate of chemical sciences - M.V. Dmitriev, B.Yu. Gavrilov.

In a note by MSM Minister A.P. Zavenyagin of the CPSU Central Committee with the presentation of draft resolutions of the Council of Ministers of the USSR and Decrees of the Presidium of the Supreme Soviet of the USSR on awards for the creation of the RDS-37 product on a new physical principle dated March 22, 1956, it was emphasized that "the idea of creating this bomb belongs to Corresponding Member of the USSR Academy of Sciences, Comrade Zeldovich I WOULD. and Academician A.D. Sakharov In the creation of the hydrogen bomb, a number of difficult scientific problems were solved under the leadership and with the direct participation of academicians Khariton Yu.B. and Kurchatova I.V." /7, p. 466/.

FIRST PLANS FOR THE DEVELOPMENT OF THERMONUCLEAR WEAPONS

The successful testing of the first thermonuclear device based on the principle of atomic compression made it possible to move on to the large-scale development of a new generation of thermonuclear charges. The creation of the RDS-37 charge was a breakthrough in solving the problem of thermonuclear weapons, and the charge itself was the prototype of all subsequent two-stage thermonuclear charges of the USSR. Immediate plans for improving thermonuclear weapons after the RDS-37 test were presented by the leaders of the MSM and the Ministry of Defense to the Presidium of the CPSU Central Committee/7, p. 429/.

From a note dated December 28, 1955 by A.P. Zavenyagina, G.K. Zhukova, I.V. Kurchatov and P.M. Zernov to the Presidium of the CPSU Central Committee with the presentation of a draft resolution of the USSR Council of Ministers:

"According to the resolution of the CPSU Central Committee of October 8, 1955, the Ministry of Medium Engineering was obliged to conduct tests:

- hydrogen bomb RDS-27 with a charge of <...> kg of uranium-235 and <...> kg of lithium-6 deuteride;

— hydrogen bomb RDS-37, based on the principle of atomic compression, with a capacity of 1.0-2.0 million tons;

- hydrogen bomb RDS-6SD with half a charge of <...>kg of uranium-235 and half power up to 1.0 million tons, in case of unfavorable test results of RDS-37.

November 6 this year The RDS-27 product was tested. The obtained capacity is 220-250 thousand tons of TNT equivalent. If INI is used in these bombs, we can expect a yield of about 300 thousand tons. November 22 The RDS-37 hydrogen bomb was tested. Due to the positive test results of the RDS-37 product, the RDS-6SD product was not tested.

Testing of the RDS-37 product with atomic compression justified all the most important scientific provisions and engineering calculations incorporated into this product. The TNT equivalent of the product turned out to be 1.7-1.9 million tons, i.e., corresponded to the maximum value expected in the calculations.

For 1956, we plan to produce 10 bombs with the same power as the tested RDS-37, and 10 bombs with a capacity of 0.5 million tons with lithium-6 <…>.

For RDS-37 products, it will be necessary to prepare new atomic auxiliary charges (initiators) with less atomic explosives and without uranium-233. We tentatively believe that <…>kg of plutonium will be sufficient for the auxiliary charge

and no more than <…> kg of uranium-235. Atomic compression makes it possible to significantly increase the overall power of manufactured hydrogen bombs. According to the five-year plan for 1956-1960. it was planned to produce 240 hydrogen bombs of the same design with a total capacity of 370 million tons of TNT and to use for this purpose <…> kg of uranium-235. It is now possible to produce several times more hydrogen bombs and with a total power much greater than previously planned, with the same consumption of atomic explosives.

As a reaction to our tests, the Americans announced that they would conduct their next hydrogen bomb tests in February-March 1956; The British are also preparing to test their hydrogen bomb. It is possible that hydrogen bombs or devices with a capacity of 10 million tons or more will be exploded during American and British atomic tests.

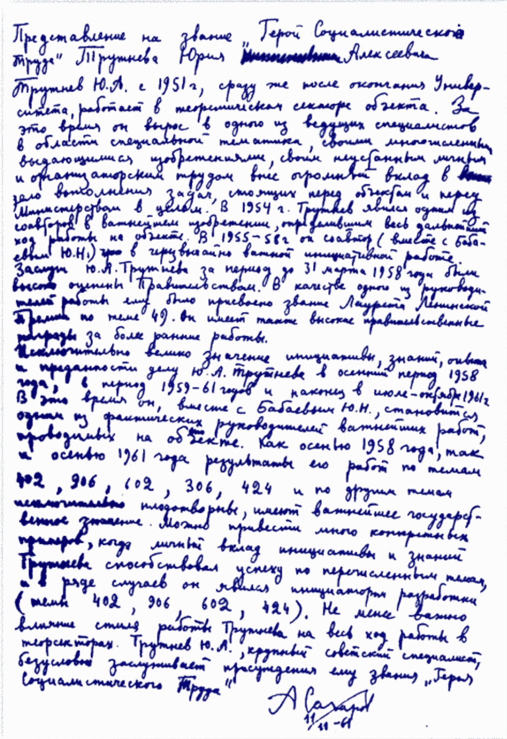
The Soviet Union's proposals to ban testing, as is known, were rejected by the Americans and the British. However, we cannot completely exclude the possibility that after their tests they will limit new tests or completely ban them. It would therefore be highly desirable to show that we can make a bomb many times stronger and also drop it from an airplane. Our bomb, in any case, should not be weaker than the British and American ones. We believe that we should prepare a bomb with a yield of 20-30 million tons by the third quarter of 1956. It will weigh 20-26 tons.

A bomb of this weight, according to the Ministry of Aviation Industry, can be carried on an M-4 aircraft. However, the aircraft's fuselage will have to be seriously strengthened and other work done. The test of this bomb must be carried out on Novaya Zemlya, because test site No. 2 in this case does not ensure the safety of the population. It is now impossible to say with complete certainty about the possibility of delivering such bombs to a distance of up to 8 thousand km. This matter requires serious study. Apparently, it will be possible to deliver them over a distance of 8 thousand kilometers.

Yuri Alekseevich Trutnev

(b. 1927),

outstanding theoretical physicist, academician of the Russian Academy of Sciences, first deputy scientific director of VNIIEF, one of the founders of the creation of domestic nuclear weapons, co-author of the physical design of RDS-37, Hero of Socialist Labor, laureate of the Lenin and State Prizes, has been working at VNIIEF since 1951.



Представление на звание „Героя Социалистического Труда" Трутнева Юрия ~~[illegible]~~ Алексеевича

Трутнев Ю.А. с 1951 г, сразу же после окончания Университета, работает в теоретическом секторе объекта. За это время он вырос в одного из ведущих специалистов в области специальной тематики, своими многочисленными выдающимися изобретениями, своим неустанным научным и организаторским трудом внес огромный вклад в дело выполнения задач, стоящих перед объектом и перед Министерством в целом. В 1954 г. Трутнев явился одним из соавторов в важнейшем изобретении, определившим весь дальнейший ход работы на объекте. В 1955–58 г он соавтор (вместе с Бабаевым Ю.Н.) в чрезвычайно важной инициативной работе. Заслуги Ю.А. Трутнева за период до 31 марта 1958 года были высоко оценены Правительством. В качестве одного из руководителей работы ему было присвоено звание Лауреата Ленинской Премии по теме 49. Он имеет также высокие правительственные награды за более ранние работы.

Исключительно велико значение инициативы, знаний, опыта и преданности делу Ю.А. Трутнева в осенний период 1958 года, в период 1959–61 годов и наконец в июле-октябре 1961 г. В это время он, вместе с Бабаевым Ю.Н., становится одним из фактических руководителей важнейших работ, проводившихся на объекте. Как осенью 1958 года, так и осенью 1961 года результаты его работ по темам 402, 906, 602, 306, 424 и по другим темам исключительно плодотворны, имеют важнейшее государственное значение. Можно привести много конкретных примеров, когда личный вклад инициативы и знаний Трутнева способствовал успеху по перечисленным темам, а в ряде случаев он являлся инициатором разработки (темы 402, 906, 602, 424). Не менее важно влияние стиля работы Трутнева на весь ход работы в теорсекторах. Трутнев Ю.А., крупный советский специалист, безусловно заслуживает присуждения ему звания „Героя Социалистического Труда"

А Сахаров
11/11-61

In 1956, in addition to a high-power bomb, it will be necessary to develop bombs with atomic compression in dimensions of 820 mm (RDS-4 dimensions). Bombs measuring 820 mm are supposed to be used on medium bombers and for missiles of the R-5M, R-11, R-12 types. In 1956, work should begin and in 1957 a product should be created using atomic compression in dimensions of 1250 mm (dimensions RDS-2 and RDS-3). Products of this size with a capacity of up to approximately 1.5 million tons can be used in the R-12 missile and the Burya cruise missile. The same charge will be suitable for the Buran cruise missile and the R-7 missile. However, these two rockets can use hydrogen charges of large dimensions and power.

Rockets as carriers of powerful hydrogen charges are of particular importance, since in this case the issue of danger from radiation and shock waves disappears. In this light, it seems absolutely necessary to develop missiles such as the R-7 for distances of 8000-9000 km, R-12 for distances of up to 2000-3000 km, R-5M for distances of up to 1200 km, and the Burya and Buran cruise missiles. , now focus on equipping them with hydrogen charges with atomic compression. Although this will be associated with additional difficulties in developing rockets, it will pay off with a significant increase in the power of the charges at a lower cost of fissile materials. We consider it necessary to draw such conclusions from the tests carried out."

8 days after this note, the corresponding Resolution of the Council of Ministers of the USSR No. 46-31SS was issued.

There were many surprises ahead. Before the moratorium on nuclear testing at the end of 1958, the USA and the USSR were actively developing their thermonuclear programs. In the period 1956-1958. The USA conducted 31 tests of powerful thermonuclear charges, 30 tests were carried out by the USSR. However, their results were very different: the United States had 4 unsuccessful tests under this program (failure or significant reduction in the quality of the thermonuclear module), and the USSR had 12 unsuccessful tests.

During this period, the United States managed to significantly expand the range of thermonuclear charges (in relation to various delivery vehicles and tasks) and improve their weight, size and military-technical characteristics. In the USSR in the period 1956-1957. the main efforts were focused on creating a serially capable modernization of the RDS-37. KB-11 and the Ural Nuclear Center NII-1011 (VNIITF), created in 1955, worked on solving this problem, which was replenished with a number of leading specialists from KB-11.

From an official document dated September 22, 1990, signed by Yu.B. Khariton /14/: "In 1955, Yu.A. Trutnev together with Yu.N. Babaev put forward a proposal that for many years determined the direction of work on the creation of domestic thermonuclear charges and formed the basis for the vast majority of developments of thermonuclear charges both at VNIIEF and at VNIITF." The charge was developed during 1956-1957. and was ready for testing in 1957. However, it was only in February 1958 that the "49" product was successfully tested (the authors of the new physical scheme and the leading developers were Yu.A. Trutnev and Yu.A. Babaev).

In the "49" product, it was possible to significantly reduce the dimensions of the charge due to a new bold solution to the problem of transfer of X-ray radiation, which determines implosion. The physical design of the charge turned out to be extremely successful, significantly improving the characteristics of thermonuclear charges and opening up new possibilities for their use. The charge was transferred to service

of new thermonuclear charges according to the "49" scheme) was completed already in 1958, but this was only part of the implementation of the necessary program. The main volume of work occurred in the period 1961-1962. This was a new important step in the development of thermonuclear charges in our country.

WORK ON CREATION OF SERIAL MODERNIZATION OF RDS-37

Already a month after the RDS-37 test in December 1955, leaders of the nuclear industry and the Ministry of Defense turned to the country's leadership with proposals for the large-scale development of the country's nuclear arsenal /7, p.429/. After 8 days, the corresponding Resolution of the Council of Ministers of the USSR No. 46-31CC is issued.

The successful test of the RDS-37 allowed us to move on to work on creating a serial modernization of this powerful thermonuclear charge. First of all, we were talking about the combat equipment of the R-7 ICBM, since it was the most effective weapon for nuclear deterrence, even in conditions of huge asymmetry between the nuclear arsenals of the USA and the USSR. There were no means of intercepting the nuclear warheads of intercontinental ballistic missiles.

Initially, the R-7 ICBM was supposed to be equipped with a thermonuclear charge of the RDS-6s type. At the same time, it was necessary to exclude the use of lithium deuteride-tritide in this charge due to the scarcity of tritium and a significant deterioration in the operational characteristics of the charge in the case of using tritium. It was also necessary to increase the energy release of the charge.

However, after the successful test of the RDS-37, the leaders of the MSM and the Defense Ministry took the initiative to equip the R-7 rocket with a new type of hydrogen charges.

Note by Deputy Chairman of the USSR CM M.V. Khrunichev, USSR Minister of Defense G.K. Zhukova,

First Deputy Minister of Medium Engineering B.L. Vannikov and others to the Presidium of the CPSU Central Committee with the presentation of the project

Resolutions of the Central Committee of the CPSU and the Council of Ministers of the USSR on equipping the R-7 rocket with a hydrogen charge based on the principle of atomic compression

April 21, 1956

According to the Resolution of the Council of Ministers of the USSR dated May 20, 1954, the Ministry of Defense Industry (NII-88, chief designer Comrade Korolev. P.) is developing the R-7 ballistic missile to transport a special charge of the RDS-6 type to a range of 8000 km. According to calculated data, the specified charge of the RDS-6 type has a power of about 1.5 million tons of TNT equivalent, its weight together with the automation equipment was set at 3400 kg. As a result of tests carried out in November 1955 of a hydrogen bomb built on a new compression principle, the possibility of creating a new hydrogen charge for the R-7 rocket with a capacity of about 2.0 million tons of TNT equivalent and a weight of 2900 kg was revealed. In accordance with the decision of the CPSU Central Committee of January 5, 1956, the issue of placing a new hydrogen charge in the R-7 rocket was studied by NII-88 MOP together with representatives of the MSM, and the possibility of placing a new charge in the head compartment of the rocket was established. Reducing the weight of the new charge compared to the previously specified weight of the RDS-6 type charge will increase the flight range of the R-7 missile by 200-300 km.

Although the RDS-37 charge met the requirements for combat equipment of the R-7 ICBM in terms of energy release, it required serious modernization. From the very beginning, the development of a modernized charge became highly competitive. Specialists from KB-11 and NII-1011 took part in it. As often happens in any new business, experts tried to introduce various types of improvements to the charge circuit. In 1956, KB-11 conducted five tests of thermonuclear devices for this purpose. However, the problem could not be solved, and in three tests the thermonuclear units failed. This was a serious blow, which testified to the insufficiency of the ideas available at that time about the processes occurring in charges of the RDS-37 type.

At the same time, NII-1011, based on the RDS-37 design, also developed powerful thermonuclear charges. In a number of cases, his developments were also plagued by serious failures. But one of the tests in 1957 to modernize the RDS-37 showed a good result. This was a charge test carried out with a special reduction in energy release in the interests of safety. As a result, the decision was made:

"to accept for the R-7 carrier the KB-11 charge, consisting of the NII-1011 thermonuclear unit and a primary atomic charge based on the RDS-4;

test the charge (modernization of RDS-37) at full explosion power."

The charge for the R-7 rocket was tested in the body of an aerial bomb. Due to the high estimated power of the thermonuclear charge and in accordance with the decision made to carry out a full-scale explosion, its testing was carried out at the Northern test site. The testing site was an experimental field located 260 km from the main base of the test site.

On October 6, 1957, a bomb was dropped from a Tu-16 aircraft at an altitude of 11,500 m. The explosion occurred at an altitude of about 2,100 m above the target, forming a blindingly bright fireball at that moment. The resulting thermonuclear charge power of 2.9 Mt exceeded the calculated one by 20%. The task of creating a serial modernization of the RDS-37 was solved.

Yuri Nikolaevich Babaev

(1928-1986),

outstanding theoretical physicist, corresponding member of the USSR Academy of Sciences, leading developer of the first thermonuclear charges, Hero of Socialist Labor, laureate of the Lenin and State Prizes, worked at the All-Russian Research Institute of Electrophysics since 1951.

In the process of developing the design of the head part (MC) of the R-7 rocket, in addition to ground laboratory design testing, flight design tests were carried out in order to determine the state of its structure, the temperature effect on it, the movements and deformation of components under the influence of real overloads and temperatures during the flight of the warhead. During flight development tests, the corresponding telemetric information was transmitted to ground registration systems. Flight tests showed the integrity of the design of the warhead and charge; the magnitudes of overloads, temperature effects and movements of structural units were within acceptable values. In general, this allowed us to conclude that the warhead of the R-7 missile is highly reliable.

The first intercontinental ballistic missile in the USSR, the R-7, with a thermonuclear charge had a firing range of about 8,000 km. A total of four missile systems were deployed, which turned out to be bulky and very expensive, with a low level of combat readiness.

The layout of the thermonuclear charge in the head of the R-7 missile had significant drawbacks associated with the peculiarities of interdepartmental relationships. The charge was not a self-contained unit, which was inconvenient for both the head part developers and the charge developers.

Since KB-11 and OKB-1 belonged to different government departments, difficulties arose, mainly related to departmental responsibility for ensuring compliance with technical requirements and the normal functioning of the structural elements of the warhead body and charge during operation and possible combat use.

Therefore, it was natural for the charge developers to strive to create a compact design of a thermonuclear charge in the form of an autonomous assembly unit in its own single housing with the corresponding installation and mounting fastening elements in the combat compartment of the warhead body, which was later realized.

It should be especially noted that the creation of missiles in the USSR devalued the multi-billion dollar US investments in air defense systems.

Note from A.D. Sakharova, Ya.B. Zeldovich and V.A. Davidenko N.I. Pavlov with an assessment of the parameters of products with a capacity of 150 megatons and one billion tons of TNT

February 2, 1956

We report an estimate of the parameters of a product with a capacity of 150 megatons of TNT.

I option.

A product with lithium deuteride <…>% enrichment can apparently be made in the following dimensions:

1) diameter 4 meters,

2) length - 8-70 meters,

3) total weight - about 100 tons.

This will require active materials in quantities:

1) U-235 - about <...> kg,

2) lithium-6 deuteride - about <...> tons,

3) natural uranium (possibly depleted) - about <...> tons.

Option II.

A product with reduced lithium-6 consumption and using natural lithium can be made in the following dimensions:

1) diameter - 6-7 meters,

2) length—18-20 meters,

3) total weight - about 500 tons. Active materials required:

1) U-235 - about <...> kg,

2) lithium-6 deuteride - about <...> tons,

3) natural lithium deuteride - about <...> tons,

4) natural uranium (possibly depleted) - about <...>tons.

A product with a capacity of one billion tons of TNT can be manufactured using any of these two options, increasing the weights of deuterides and natural uranium by 6-7 times, and the weights of fissile materials by approximately 3 times.

THE PROBLEM OF CREATING A SUPERBOMB

The significant lag between the USSR and the United States in terms of the number of nuclear warheads and the megatonnage of the nuclear

It should be noted that the idea of a superbomb was initially considered in the United States. In 1954, Edward Teller expressed the idea of the possibility of developing a thermonuclear charge with an energy release of 10,000 Mt. In 1956, the Pentagon developed requirements for warheads with a yield of 100 Mt, and the Los Alamos laboratory substantiated the possibility of creating a thermonuclear charge with an energy release of 1000 Mt/4/.

Similar proposals were formulated in KB-11 almost immediately after the successful test of the RDS-37/7, p. 440/.

In the note by A.P. Zavenyagina, G.K. Zhukova, I.V. Kurchatova, P.M. Zernov to the Presidium of the CPSU Central Committee contained specific proposals for the development and testing of a bomb with a yield of 20-30 Mt and a mass of 20-26 tons on Novaya Zemlya.

The development of an ultra-high-power charge began in 1956 at NII-1011 and was called "Project 202". This project was a development of the principles of RDS-37 and was aimed at achieving an energy release of 30 Mt. An aerial bomb was supposed to be used as ammunition using such a thermonuclear charge, for which the necessary body and parachute system were developed. It should be noted that, due to its overall characteristics, this aerial bomb did not fit inside the bomb bay of the Tu-95 heavy bomber, which entered service in 1957.

On June 6, 1956, NII-1011 issues a report justifying the characteristics of the RDS-202 charge with an estimated power of 38 Mt /7, p. 480/. The report "Basic calculation data of RDS-202" was signed by the deputy. Ch. designer Zababakhin E.I., head of sector 1 Romanov Yu.A. The report was compiled by Avrorin E.N., Vakhrameev Yu.S., Zababakhin E.I., Nechaev M.N., Rozanov V.B., Romanov Yu.A. Feoktistov L.P., Churazov M.D., Shumaev M.P., Imshennik V.S., Ptitsyn A.R., Strotsev V.I. took part in the work.

At the end of the moratorium in 1961, the task of creating a superbomb was returned to, but now it was a question of a thermonuclear charge with an energy release of 100 Mt, which was planned to be placed in an aerial bomb developed according to "Project 202". At this stage, the development of a new super-powerful charge was carried out in KB-11 on the initiative of Yu.A. Trutnev and A.D. Sakharov, the team of authors also included V.B. Adamsky, Yu.N. Babaev and Yu.N. Smirnov. Original solutions and accumulated experience made it possible to implement this development extremely quickly, and the charge was successfully tested on October 30, 1961.

The thermonuclear charge with special measures to reduce the experimental energy release worked in the designed mode, the energy release of the explosion was 50 Mt. Thus, a superbomb with a full-scale energy release of 100 Mt was created. Although this charge was not put into service (ballistic missiles, which began to be considered as the main means of delivering nuclear weapons, did not have sufficient carrying capacity), nevertheless, the creation and testing of the superbomb was of great political importance. It demonstrated that the USSR had solved the problem of achieving almost any level of megatonnage of its nuclear arsenal. It is interesting to note that after this the growth of the megatonnage of the US nuclear arsenal stopped.

Museum of Nuclear Weapons RFNC-VNIIEF

N.N. Semenov, I.B. Tamm, N. Bor

12. FUNDAMENTAL SCIENTIFIC BASES OF RADIATION IMPLOSION

The creation of the RDS-37 and subsequent generations of thermonuclear charges is based on fundamental scientific concepts of high energy density physics. Let us present a number of areas of research into physical processes related to the principle of radiation implosion. This principle assumes:

the release of a significant part of the energy during the explosion of a nuclear charge (primary module) in the form of X-ray radiation;

transportation of X-ray energy to the thermonuclear module;

implosion of the thermonuclear module using the energy of the "delivered" X-ray radiation.

The explosion of a nuclear charge, in which the main part of the energy is released in neutron-nuclear reactions in the fissile substance, is accompanied by the transformation of this energy into X-ray radiation and thermal energy of the substance, which are in local thermodynamic equilibrium (as well as into the kinetic energy of the environment). The substance carries out the transfer of X-ray radiation, which is emitted from the surface of the fissile material and then propagates inside the outer regions of the primary module. This mechanism significantly depends on fundamental characteristics—the range of interaction of X-ray quanta with matter. For substances such as uranium, photoabsorption processes and discrete-discrete transitions are of decisive importance.

Studies of this stage of the process have been carried out for decades both within the framework of the radiative thermal conductivity approximation and within the framework of spectral kinetics. A number of physical and mathematical models of radiation gas dynamics were created at RFNC-VNIIEF, which were adapted to the computing capabilities of their time. Currently, 3D models in the approximation of radiative thermal conductivity and 2D models based on the spectral kinetic equation of radiative transfer, combined with gas dynamics equations, are used.

Work on calculating radiation paths in various media was carried out for a long time on assignments from VNIIEF at the Institute of Applied Mathematics of the Academy of Sciences. Now, in relation to new computing capabilities, RFNC-VNIIEF has created precision programs for calculating spectral radiation paths for various substances and conditions, as well as algorithms for calculating group and average paths in accordance with the needs of radiation gas dynamics models.

Studies of radiation gas dynamics processes made it possible to control the transfer of X-ray radiation inside the primary module and dramatically improve the quality of modules as energy sources for radiation implosion, which was extremely important for practice.

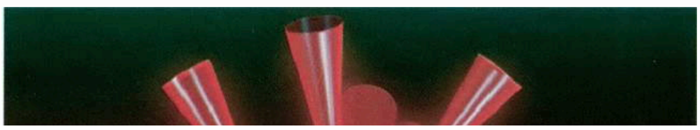
The second part of the radiation implosion principle is mainly associated with studies in radiation gas dynamics models of the processes of reflection and transmission of X-ray radiation through layered configurations of various materials, often representing multi-element geometric figures with complex dynamics. The practical result of these studies was to determine the amount of energy supplied for the radiation implosion of thermonuclear modules. If at the first stage the main requirement involves maximizing the amount of X-ray energy emerging from the primary module, then at the second stage this requirement is to minimize energy losses.

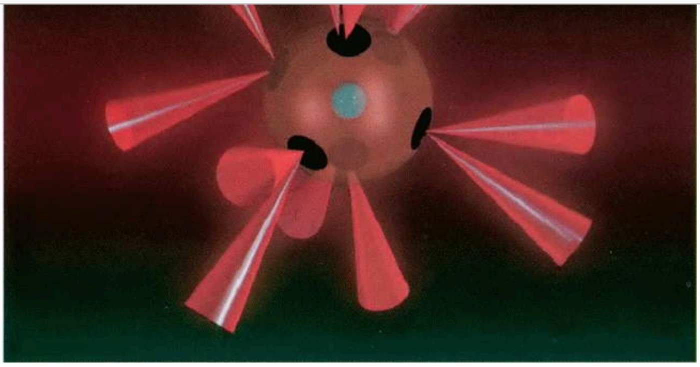
The third part of the radiation implosion principle is associated with studies of the transformation of X-ray energy in the pressure field compressing the thermonuclear module. This field is a complex result of the process of radiation propagation in various materials and has an axisymmetric structure. To obtain acceptable results of compression of the thermonuclear module, it is necessary to transform the axisymmetric boundary conditions into the symmetrical nature of the implosion. The solution to this problem requires control of radiation fluxes and gas-dynamic flows of both high-temperature and low-temperature high-density plasma, which is provided within the framework of 2nd models of radiation gas dynamics.

It should be noted that the features of the "boundary conditions" are such that the implosion of a thermonuclear module can be either relatively stable or unstable. There are important practical applications when processes are three-dimensional in nature, and for these purposes, RFNC-VNIIEF has developed 30 models of radiation gas dynamics.

The main role in solving these problems is played by methods of physical and mathematical modeling, which is determined by the characteristics of the information obtained during testing of thermonuclear charges. The largest experimental result was the determination of "stability zones" of radiation implosion of thermonuclear modules, as well as the determination of physical factors that lead beyond these zones.

We emphasize that the implementation of the principle of radiation implosion is an outstanding example of how a fundamental scientific discipline has provided the design of structures in which highly complex physical processes are intertwined, for which experimental data were limited regarding key parameters. The enormous practical achievements obtained on the basis of radiation gas dynamics have made us, of course, leaders in this field, at least on par with research in the United States.





Spherical chamber of the powerful laser system "Iskra-5"

View of the city under construction, 1956

Mira Avenue, 1959

Kurchatova Street

Khariton Street

13. TRANSFORMATION OF KB-11 INTO A MULTI-INDUSTRIAL NUCLEAR CENTER OF THE COUNTRY

The first series of atomic charges of the RDS-1 type in the amount of 5 units was laid down for storage in KB-11 already in 1950. The beginning of the nuclear arsenal of the Soviet Union was laid here!

The first nuclear weapon of submarines was the T-5 torpedo, then the R-11 FM missile and a cruise missile. The first ballistic missile with a thermonuclear charge for submarines was the R-13, and the first with an underwater launch was the R-21 missile. All of these weapon systems were equipped with charges that had been tested and tested by that time in KB-11.

In 1953, the Ministry of Defense raised the issue of the need to create an anti-ballistic missile defense (ABM) system to the CPSU Central Committee. Specialists of KB-11 N.A. Dmitriev, V.N. Rodigin, D.A. Frank-Kamenetsky showed in 1954 that the best way to protect against enemy nuclear weapons is a high-altitude nuclear explosion. An anti-aircraft missile with an atomic charge (B.D. Bondarenko) and automatic detonation (G.N. Dmitriev, V.A. Grubov and employees) developed by KB-11 was tested in 1957. The layout of the charge and automation was carried out by KB-25 (N.L. Dukhov, A.A. Brish and colleagues).

In 1954, the document “Atomic Weapons for Tactical Purposes” was prepared for the country’s top leadership by Malyshev, Vannikov, Khrunichev, Kurchatov, Khariton and Lavrentyev. In fact, this document contained not only a justification for the need, but also a statement of the program for the development of tactical nuclear weapons, including artillery ones. Work in this direction was implemented in 1956 with a successful test at the Semipalatinsk test site. The field testing was supervised by E.A. Negin.

The experience of working with charges of various powers was enriched, and confidence in their reliability grew. Back in November 1948, Ya.B. Zeldovich and V.A. Zuckerman, a year earlier than in the United States, proposed a new principle of neutron initiation - an external source of neutrons, part of the bomb’s automation, which made it possible to increase the power of nuclear weapons by one and a half times, and most importantly - to increase the reliability and safety of nuclear weapons. To many at that time, this idea seemed technically impracticable. Based on the new design principles of 1953, new low-yield tactical bombs were created. In September-October 1954, field tests of four such bombs took place. Moreover, one explosion was produced when it hit the ground from the contact of the sensors. The tests were successful.

The transition to the use of an external source of neutron initiation has radically increased the degree of nuclear explosion safety and reduced the likelihood of a nuclear explosion during an accident by several orders of magnitude.

On October 23, 1954, air tests of the “product” RDS-3 “I” were carried out at the Semipalatinsk test site. Its power was 62 kilotons, which is almost one and a half times more than the energy release of a similar “product” with a neutron fuse, that is, with the old initiation system. A new neutron initiation system proposed by Ya.B. Zeldovich and V.A. Zuckerman, has become widespread, and has opened up new opportunities for further increasing the specific power of charges and improving their performance characteristics. On January 22, 1955, the USSR Council of Ministers approved a plan for the production of atomic and thermonuclear bombs, as well as atomic charges for R-5M missiles in the amount of 158 pieces (of which 8 thermonuclear bombs) / 7, p. 304/.

In 1955, at the suggestion of A.I. Pavlovsky in KB-11 began research on the creation of iron-free betatrons for radiography of fast processes. Implementation of A.I.’s ideas Pavlovsky and his school immediately brought KB-11 to a new level of development of accelerator technology, and the created installations are in demand to this day and are a powerful tool for maintaining the nuclear arsenal of our country.

Alexander Ivanovich Pavlovsky

(1927-1993),

outstanding scientist, founder of the school of high-current accelerators and generators of ultra-powerful pulsed magnetic fields, academician of the Russian Academy of Sciences, deputy scientific director, head of the nuclear physics department KB-11 (VNIIEF), Hero of Socialist Labor, laureate of Lenin and four State Prizes

Samvel Grigorievich Kocharyants

(1909-1993),

outstanding designer, leading developer of the first atomic and thermonuclear ammunition and nuclear missile equipment, chief designer of nuclear weapons (1959-1990), twice Hero of Socialist Labor, laureate of Lenin and four State Prizes

* * *

The nuclear physics research program necessary to create the first thermonuclear charges largely served as the basis for the subsequent development of nuclear physics in the USSR.

When justifying the characteristics of the RDS-37, the results of numerical calculations carried out on the domestic electronic computer "Strela" using programs developed by our scientists were used for the first time. The appearance in the Department of Mathematics of the Mathematical Institute of the USSR Academy of Sciences in 1954 of the first samples of the Strela computer with a productivity of 2000 operations per second (the norm for a mathematician-computer on a Mercedes is 800 operations per working day) marked the beginning of a new era in the field of computational mathematics and physics -theorists received a new tool for conducting numerical experiments with the designs of thermonuclear charges.

The first samples of domestic computers arrived at KB-11 in 1956. Already in mid-1956, the M-20 computer was manufactured with a productivity of 20,000 operations per second, i.e. with a performance that is an order of magnitude superior to the Strela computer. In the same year, serial production of the M-20 /7 was launched, p. 494/, and in KB-11 a building began to be built on site 21 to house these machines.

The KB-11 work plan for 1955, approved by the Minister of the Council of Ministers on April 13, 1955, included R&D and R&D for the development of five nuclear and thermonuclear charges and eight warheads, and this is in addition to RDS-37 / 7, p. 336/.

An important area of work for KB-11 in 1954 and 1955. was participation in testing the first medium-range missile R-5M with a detachable warhead. Successful test tests of this missile (range 1200 km) with the detonation of a nuclear charge with a power of 0.3 kg in the Aralsk region took place on February 2, 1956 (from KB-11 the work was led by S.G. Kocharyants and E.A. Negin). The first nuclear warhead with an atomic charge of the RDS-4 type was put into service as part of the R-5M missile in 1956.

The beginning of our country's nuclear missile shield has been made.

K.) left the "object". I. Shchelkin), seven doctors of science (V.I. Alferov, V.K. Bobylev, E.I. Zababakhin, G.N. Flerov, A.F. Belyaev, E.K. Zavoisky, Yu.Ya. Pomeranchuk) and 15 candidates of sciences.

At the end of 1955, 2 academicians (Yu.B. Khariton and A.D. Sakharov), 2 corresponding members (Ya.B. Zeldovich and L.A. Galin), five doctors of science (L. V. Altshuler, V.A. Davidenko, Yu.A. Zysin, V.A. Tsukerman and part-time K.A. Semendyaev), 32 candidates of sciences, 1032 engineers and 868 technicians.

There were 110 scientific workers at the "facility". In total, KB-11 employed 10,549 people, including those with higher education.

1,142 employees had education, 1,011 had specialized secondary education and 501 had secondary education, the remaining 7,829 employees had incomplete secondary education.

About 25 thousand people lived in the city. In the mid-50s, massive construction of the city began.

The significance of the nuclear weapons complex for the country in those years was emphasized by the level of industry leaders - the first ministers of the MSM were in the rank of Deputy Chairman of the Council of Ministers. On February 28, 1955, A.P. was appointed Minister of MSM and Deputy Chairman of the Council of Ministers of the USSR. Zavenyagin, who replaced V.A. in this post. Malysheva. In the same year, a restructuring took place within the MSM itself: a centralized construction complex was created, and work on the creation of missile systems and other delivery vehicles was transferred from the MSM to the Special Committee of the Council of Ministers.

Thus, by the mid-50s, the nuclear industry turned into a powerful knowledge-intensive and technologically developed center of the country with a vertically integrated management scheme for carrying out large-scale work in the field of peaceful nuclear energy and work on the creation of various types of nuclear and thermonuclear weapons to ensure the security of the USSR and his allies.

***

Boris Glebovich Muzrukov

(1904-1979),

outstanding technologist and production organizer, chief metallurgist of the Kirov plant, director of Uralmash (1939-1947), director of the Mayak plant (1947-1953), head of the department of the Ministry of Medium Engineering (1953-1955), director of KB-11 (1955-1974) , twice Hero of Socialist Labor, laureate of Lenin and two State Prizes

Evgeniy Arkadyevich Negin

(1921-1998),

outstanding designer and gas dynamics, academician, leading developer of the first atomic and thermonuclear charges, chief designer of nuclear charges (1959-1991), director of VNIIEF (1978-1987), Hero of Socialist Labor, laureate of Lenin and three State Prizes

Vyacheslav Aleksandrovich Malyshev

(1902-1957),

an outstanding leader and organizer of industry, People's Commissar of Medium Engineering, during the war years - People's Commissar of the Tank Industry, since 1945, member of the Engineering and Technical Council of the Special Committee, in 1952-1953. - Member of the Presidium of the CPSU Central Committee, in 1953-1955. - Minister of Medium Engineering, at the same time Deputy Chairman of the Council of Ministers of the USSR, Chairman of the State Commission for Testing RDS-6s 08/12/53, Hero of Socialist Labor, twice laureate of the State Prize

Abraham Pavlovich Zavenyagin

(1901-1956),

outstanding leader and organizer of industry, one of the founders of the nuclear industry, member of the Special Committee (1945-1953), Minister of Medium Engineering (1955-1956), at the same time deputy chairman of the Council of Ministers of the USSR, participant in the RDS-37 test, Hero of Socialist Labor, twice laureate of the State Prize

Mikhail Georgievich Pervukhin

(1904-1978),

outstanding leader and organizer of the nuclear industry, since 1940 - Deputy Chairman of the Council of People's Commissars of the USSR, senior administrative head of the Atomic Project (1942-1945), since 1945 - member of the special committee, awarded the title of Hero of the Socialist for organizing work on RDS-1 Labor, in 1957 - Minister of Medium Engineering and First Deputy of the Council of Ministers of the USSR

Efim Pavlovich Slavsky

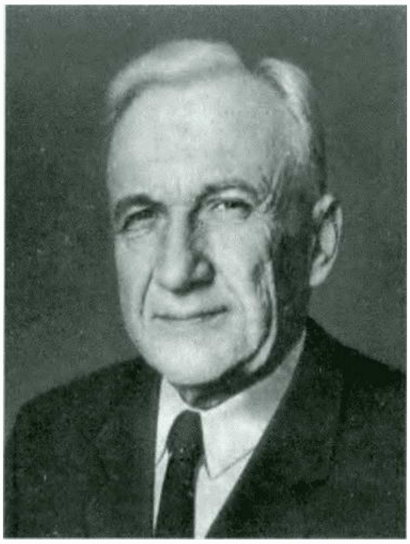
(1898-1991),

outstanding leader and organizer of industry, deputy head of the PSU (1946-1953), first deputy minister of medium-sized mechanical engineering (1953-1957), minister of medium-sized mechanical engineering, three times Hero of Socialist Labor, holder of ten Orders of Lenin, laureate of Lenin and three State Prizes

LEADERS OF SCIENTIFIC SCHOOLS KB-11 (VNIIZF) IN THE EARLY 50S OF THE XX CENTURY

Yu.B. Khariton

I WOULD. Zeldovich



I.E. There M

HELL. Sakharov

N.I. Bogolyubov

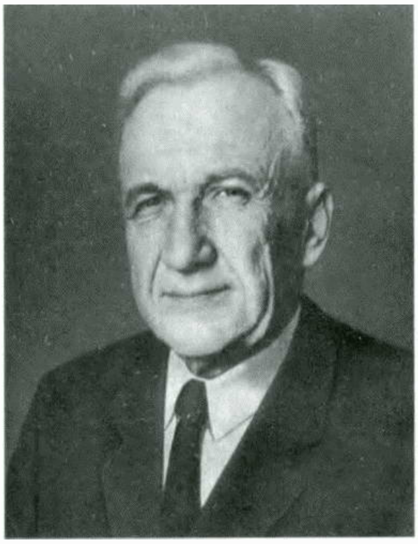
M.A. Lavrentiev

G.I. Flerov

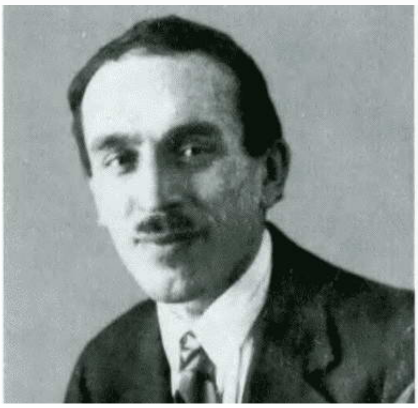
YES. Frank-Kamenetsky

PARTICIPANTS IN THE DEVELOPMENT OF THE FIRST THERMONUCLEAR WEAPONS, WHO LATER BECAME NOBEL PRIZE WINNERS

L.D. Landau



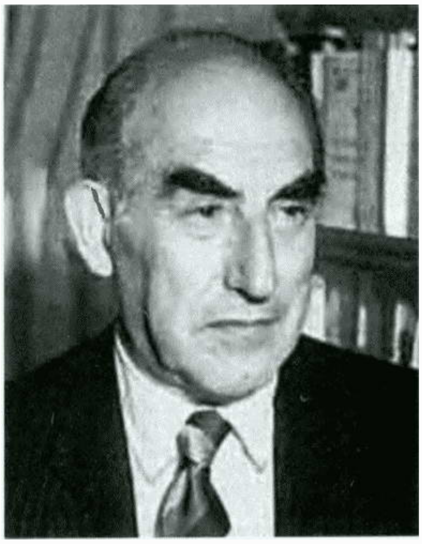
I.E. There M



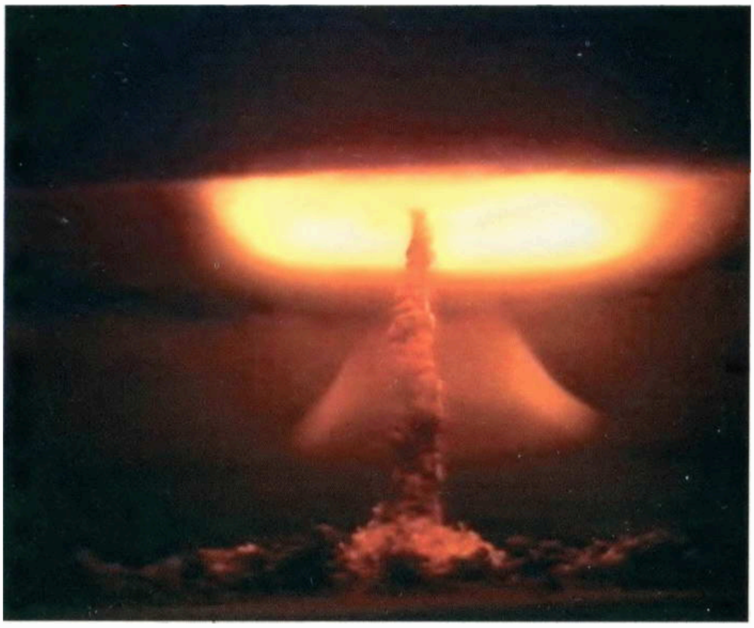
N.I. Semenov

L.V. Kantorovich

THEM. Franc



14. CHRONICLES OF EVENTS LEADING TO THE CREATION OF RDS-37



OCTOBER 22, 1945

At a meeting of the Technical Council of the Special Committee, intelligence material was presented on the possibility of initiating a nuclear reaction in light nuclei using an atomic bomb as an auxiliary means.

DECEMBER 17, 1945

At a meeting of the technical council of the Special Committee Ya.B. Zeldovich presented a report “On the possibility of exciting reactions in light nuclei.” The report is based on the report of I.I. Gurevich, Ya.B. Zeldovich, I.Ya. Pomeranchuk, Yu.B. Khariton "Use of nuclear energy of light elements." It has been proposed to use nuclear reactions for explosive purposes, converting deuterium into hydrogen and tritium by detonation.

JANUARY 28, 1946

At a meeting of the Technical Council of the Special Committee, intelligence material on the “Super” project (deuterium superbomb) in the United States was presented. The material contained a schematic diagram of a superbomb and characteristics of the main physical processes occurring in deuterium plasma during its explosion.

NOVEMBER 3, 1347

At the meeting of the Scientific and Technical Council of PSU, a report was presented by Ya.B. Zeldovich based on the work of S.P. Dyakova, Ya.B. Zeldovich and A.S. Kompaneitsa “On the issue of using intra-atomic energy of light elements”, carried out at the Institute of Chemical Physics. In general, the issues of the possibility of thermonuclear combustion under equilibrium and nonequilibrium conditions of the state of matter and radiation are considered.

APRIL 6, 1948

Decree of the Council of Ministers of the USSR No. 1127-402ss/op obliged the ICP and KIPT in 1948 to carry out preliminary calculations for the superbomb (responsible: Ya.B. Zeldovich, K.D. Sinelnikov).

APRIL 23, 1948

New materials received from K. Fuchs on the Super project included an analysis of the ignition of deuterium plasma and a diagram of the Fuchs-von Neumann “product,” which was a prototype of a radiation implosion scheme. L.P. Beria sent materials to B.L. Vannikov, I.V. Kurchatov and gave instructions to familiarize Yu.B. with them. Khariton.

JUNE 5, 1948

Decree of the Council of Ministers of the USSR No. 1989-773ss/op obliged KB-11 (Khariton and Zernov) to carry out theoretical and experimental verification of the data before July 1, 1949 and to develop by January 1, 1949, based on the available data, a preliminary design of the RDS-6 (hydrogen bomb type "Super")

JUNE 10, 1948

Decree of the Council of Ministers of the USSR No. 1990-774ss/op obliged the Lebedev Physical Institute (S.I. Vavilov) to organize research on the development of the theory of deuterium combustion under the leadership of I.E. Tamm (on instructions from Laboratory No. 2, Khariton and Zeldovich).

1948

The report “Gas-dynamic studies of the process of expansion of a ball” (L.D. Landau, E.M. Lifshits, I.M. Khalatnikov) considered the issues of energy release of nuclear charges, taking into account energy losses due to the release of X-ray radiation. A prototype for calculating the X-ray energy output from primary charges in an AO scheme.

NOVEMBER 20, 1948

V.L. Ginzburg released a report “Investigation of the issue of detonation of deuterium,” in which he analyzed the problems of detonation of deuterium and mentioned the “puff” of A.D. Sakharov.

Report by I.E. Tamm "On the use of a mixture of natural uranium and deuterium as an explosive," which presents an analysis of a number of issues regarding the operation of the "sloyka".

DECEMBER 18, 1948

Report by A.S. Kompaneets and S.P. Dyakov "On the use of nuclear energy of the DD reaction" presents a report on the work of the group of Ya.B. Zeldovich at the ICP on a cylindrical deuterium superbomb.

JANUARY 20, 1949

Report by A.D. Sakharov "Stationary detonation waves in a heterogeneous system of heavy water and uranium-238."

MARCH 3, 1949

Report by V.L. Ginzburg "Use of Li^{6} D in a "puff paste"", which examines the advantage of Li^{6} deuteride compared to heavy water as a thermonuclear fuel.

FEBRUARY 9, 1950

Note from A.D. Sakharov on multilayer charge using implosion and a nuclear initiator.

FEBRUARY 26, 1950

Decree of the Council of Ministers of the USSR No. 827-303ss/op "On work on the creation of RDS-6" obliged PGU, Laboratory No. 2 and KB-11 in June 1952 to test the small multilayer charge RDS-6s according to the principle proposed by A.D. Sakharov, and to organize a calculation and theoretical group in KB-11 under the leadership of I.E. for its development. Tamma. The decree also obliged the PSU, Laboratory No. 2 and KB-11 to organize theoretical calculations, as well as experimental and design work on the creation of the RDS-6t, and the IFP (Alexandrov and Landau) to investigate the possibility of stationary propagation of the reaction in the pipe by the 1st quarter of 1952 filled with deuterium.

FEBRUARY 26, 1950

Resolution of the Council of Ministers of the USSR No. 828-304ss/op "On the organization of tritium production" (the first stage provided for ensuring the production of tritium in an amount of 1.5 kg/year).

JULY 1, 1950

Resolution of the Council of Ministers of the USSR No. 2859-1147ss/op "On carrying out design and pilot work on the production of lithium-6" (initially, the production volume of lithium-6 was supposed to be ensured at the level of ~ 4 kg/month with a content of lithium-6 isotope ~ 95%).

OCTOBER 26, 1950

Report "On the theory of the initiator for "T"" (N.A. Dmitriev, G.M. Gandelman, V.Yu. Gavrilov), which examines various possibilities for creating an "initiator" for RDS-6t (if conditions for detonation are provided deuterium in the "pipe"). The initiation process was supposed to be carried out by igniting a capsule with a TD mixture by a shock wave of a nuclear explosion propagating through the heavy substance in which the capsule is located.

MAY 3, 1951

Decree of the CM of the USSR No. 1552-774ss/op "On work on RDS-6t" obliged PGU to organize parallel work at the Institute of Physical Problems (L.D. Landau), calculation and theoretical work at the Mathematical Institute of the USSR Academy of Sciences under the leadership of M.V. Keldysh and in Laboratory "B" (IPPE) under the leadership of D.I. Blokhintseva. The resolution was due to the absence by this time of definite conclusions on the feasibility/non-feasibility of RDS-6t. At the same time, the Resolution provided for the creation of a special section at the NTS PGU on the development of high-speed computers.

OCTOBER 22, 1952

Note from Ya.B. Zeldovich I.V. Kurchatov and N.I. Pavlov with a proposal for research on the issue of acceleration of metal plates/shells by a nuclear explosion to provide heavy-duty products 6c (Davidenko, Sakharov, Zeldovich). Atomic compression prototype.

MARCH 25, 1953

Order of the Council of Ministers of the USSR No. 5537-rs/op determined among the most important works of KB-11 in 1953 the creation of the RDS-6s model with an energy release of at least 250 kg and a mass of 5 tons and its testing in ground conditions (on a tower) in order to create a hydrogen product with a capacity of 1 million tons.

JULY 15, 1953

The report "Product Model RDS-6s" was issued by I.E. Tammom, A.D. Sakharov and Ya.B. Zeldovich as a justification for the prepared field test. The report states that the combat product will differ from the model by 2-3 times more tritium and U-235.

AUGUST 12, 1953

Successful test of RDS-6s.

OCTOBER 17, 1353

Proposal by A.D. Sakharov on the development of RDS-6 without tritium using D-gas, with an energy release of 0.8-1.5 Mt.

NOVEMBER 20, 1953

In Resolution of the Council of Ministers of the USSR No. 2835-1198ss "On the development of a new type of powerful hydrogen bomb", the proposal of the Council of Ministers for the development of a new RDS proposed by A.D. Sakharov is accepted, and Andrei Dmitrievich is approved as the scientific director of the work. Testing of the RDS-6SD prototype (energy release ~ 1 Mt) is planned for the end of 1954.

JANUARY 14, 1954

Note from Ya.B. Zeldovich and A.D. Sakharov on the use of atomic compression of a thermonuclear unit with hydrodynamic transfer of energy of the primary charge (proposal by V.A. Davidenko).

At a meeting with Yu.B. Khariton noted that the question of the existence of a stationary detonation regime in the RDS-6t still did not receive a positive answer. It is proposed to focus on creating large products like RDS-6s.

MARCH 26, 1954

Resolution of the Council of Ministers of the USSR No. 525-230 determined that the most important tasks of MSM and KB-11 in 1954 were the creation of the RDS-6SD with an energy release of 2 Mt, the manufacture and testing of a prototype of this product with a power of 1 Mt in the dimensions of the RDS-6s.

APRIL 28, 1954

Assignment G.M. Gandelman and N.A. Dmitriev to carry out calculations in the Department of Mathematics of the Institute of Mathematics on heating the wall of the product with X-ray radiation. The first evidence of the appearance of elements of the principle of radiation implosion.

JUNE 24, 1954

Letter from the management of KB-11 to Minister V.A. Malyshev about the possibility of creating a hydrogen bomb based on atomic compression.

JULY 18, 1954

The decision of the technical meeting under Minister V.A. Malyshev confirmed the development of the RDS-6SD for testing at the end of 1954 (power ~ 1 Mt). It is noted that due to a lack of calculation data, it is impossible to select the final version of the design with a capacity of 2 Mt in the dimensions of RDS-6s.

JULY 31, 1954

Resolution of the USSR Council of Ministers No. 1562-702ss “On the program and procedure for testing RDS...” prescribed: “Due to the fact that detailed calculations of the first versions of the RDS-6SD product showed that these options do not provide the TNT equivalent of 2 million tons <...> , accept the proposal of MSM and KB-11 to postpone to the second quarter of 1955 the deadline for completing the development of the RDS-6SD product with a full TNT equivalent of 1.7 to 2 million tons in the dimensions of the RDS-6s product.”

AUGUST 6, 1954

In the report on the work of sector No. 1 KB-11 for the first half of 1954, signed by A.D. Sakharov and Yu.A. Romanov, noted the intensive work on atomic compression.

DECEMBER 9, 1954

A.D. report released Sakharov and D.A. Frank-Kamenetsky “Atomic compression” with a description of the general features of the principle of radiation implosion and thermonuclear charges based on it.

DECEMBER 9, 1954

A joint work plan for sectors 1 and 2 of KB-11 on the problem of atomic compression was released, which included a wide range of JSC issues, in particular, the development of a model system (the future RDS-37 charge) for testing at the test site. Completion of the work was planned for the end of 1955.

DECEMBER 10, 1954

A note from the management of KB-11 to Minister V.A. Malyshev with a proposal to completely stop work on the RDS-6t product.

DECEMBER 24-25, 1954

Extended meeting of the Scientific and Technical Council KB-11 with the participation of Minister V.A. Malyshev decided to develop a model system using the atomic compression scheme for testing in 1955.

FEBRUARY 3, 1955

Technical specifications for the design of an experimental product intended to test the scientific principles underlying products with atomic compression (A.D. Sakharov, D.A. Frank-Kamenetsky, L.P. Feoktistov).

FEBRUARY 16, 1955

The resolution of the Presidium of the CPSU Central Committee approved the MSM proposal to develop a powerful hydrogen bomb based on the AO principle.

MAY 31, 1955

Decision of the meeting with the Minister of Medium Engineering (A.P. Zavenyagin): “To approve the design of the RDS-37 experimental device presented by KB-11 for testing at test site No. 2 in 1955. <...> To approve the design of the RDS-6SD product presented by KB-11 for tests at test site No. 2 in 1955. Consider it expedient to resolve the issue of testing the RDS-6SD product after testing the RDS-37.”

JULY 1, 1955

Report of the commission (under the leadership of I.E. Tamm) on the consideration of the physical principles of atomic compression and calculations of the experimental device RDS-37. “Atomic compression, based on the use of radiant thermal conduction, opens up completely new possibilities in the field of atomic weapons.”

JULY 8, 1955

The final report on the development of RDS-37 “Experimental device for testing the principle of encirclement” has been released.

OCTOBER 8, 1955

Resolution of the Council of Ministers of the USSR No. 1808-967ss “On testing RDS products” prescribes “acceptance of proposals from the MSM and the Ministry of Defense to conduct tests in October-November 1955 of new designs of powerful RDS products,” including “an experimental design of a hydrogen bomb with atomic compression with expected TNT equivalent of 1-2 million tons.”

NOVEMBER 22, 1955

CONCLUSION

The work on creating the RDS-37 thermonuclear charge based on the principle of radiation implosion was highly appreciated in a letter to A.P. Zavenyagina, G.K. Zhukova, I.V. Kurchatova, P.M. Zernov to the Presidium of the CPSU Central Committee with the presentation of a draft resolution of the Council of Ministers of the USSR dated December 28, 1955 /1/: "The successful test of the RDS-37 product showed the maturity of our physicists, the originality of their ideas, courage and confidence in new areas of scientific research. The merit in this extremely important matter belongs to both the physicists who put forward the idea of creating a hydrogen bomb on the principle of atomic compression, corresponding member of the Academy of Sciences Zeldovich and Academician Sakharov, as well as other major physicists who supported the KB-11 initiative with their knowledge and authority. This is Academician Khariton, who led the work on the practical creation of the product, as well as the expert commission of Academicians Tamm and Keldysh. The creation of the RDS-37 product with atomic compression is the most important achievement of Soviet physics."

At a meeting of the Presidium of the CPSU Central Committee on January 5, 1956, it was noted:

"1. Accept the presented t.t. Zavenyagin, Zhukov, Kurchatov and Zernov draft resolution on this issue.

2. Express gratitude to our scientists, engineers and work managers who took part in the creation of a new type of hydrogen bomb, the testing of which showed the maturity of Soviet physicists, the originality of their ideas, courage and confidence in new areas of scientific research.

3. Instruct the MSM (Comrade Zavenyagin) to submit proposals to the CPSU Central Committee to nominate scientists, engineers and technical workers who participated in the work on creating a new type of hydrogen bomb for awards."

The creation of the RDS-37 determined the main vector of development of the domestic nuclear weapons program and gave a powerful impetus to movement towards nuclear parity and the implementation of nuclear deterrence.

A huge credit goes to I.V. Kurchatova and Yu.B. Khariton was that they were able to form such a team of like-minded people and at the same time bright individuals who were "up to the task" of the task. It was in this team that traditions and a style of work were born and strengthened, ensuring not only the ultimate success of the initial stage of the nuclear program, but also the further accelerated development of advanced branches of science, technology, and production. Ultimately, this made it possible to create the nuclear shield that ensures the security of our Fatherland.

The merit of the leaders of the atomic program on the "places," primarily KB-11, is that they themselves rose to the occasion, both in terms of scientific, technical, and simply human.

What lessons can be learned from the events that led to the creation of the first thermonuclear bomb RDS-37 in 1955? Firstly, this is a lesson in the purposeful rational organization of all work on the atomic problem. Secondly, a lesson in how to attract all the intellectual power of the country to fulfill the state task. Thirdly, this is an example of how to respond to a breakthrough in the scientific field that has enormous defense significance. Fourthly, this was the first example of creating a deterrent weapon based on the most advanced technologies, determined by the achievements of fundamental science.

Peaceful sky over Moscow

In the mid-50s, the size of the army was reduced from 5,763,000 people in 1955 to 3,623,000 people in 1958.

The creation of thermonuclear weapons in the USSR made a world war impossible.

APPLICATIONS

1. ABOUT THE "GEORGE" EXPERIMENT

The George test was carried out on May 9, 1951 at Enewetak Atoll. The device was placed at an altitude of 200 feet (61 m) on a test tower. The energy release of the explosion was 225 kt. The purpose of the experiment was to ignite a thermonuclear reaction.

The Cylinder test device consisted of a core containing highly enriched uranium, which was compressed by a unique cylindrical implosion system. It is believed that this device was the first to use an external neutron initiation system /4/.

into a narrow channel by implosion, transmitted radiation into a small volume of beryllium oxide containing several grams of a liquid mixture of deuterium and tritium. The radiation not only heated the thermonuclear module to the temperature required for ignition, but also created pressure in the surrounding beryllium oxide, which led to compression of the thermonuclear fuel, intensifying its combustion. The radiation propagated ahead of the front of the shock wave created by the nuclear explosion, providing the necessary time for the thermonuclear process to occur before it was disrupted by the products of the nuclear explosion.

The thermonuclear part of the device was developed by E. Teller, and the Cylinder device was probably developed on the basis of proposals by Mr. Gamow.

Thermonuclear combustion was detected through measurements of the X-rays emitted by the fusion plasma. The recording equipment was protected from the effects of X-ray and gamma radiation from a nuclear charge and was located far enough from the device, providing measurements and data transmission during the combustion of thermonuclear fuel. This part of the experiment was carried out under the direction of H. Bradner and Mr. York. The X-ray measurements were based on the fluorescence process of a series of K-threshold filters placed on a base defined by the test tower. X-ray radiation from the thermonuclear module reached the recorders through vacuum channels located inside a tube made of lead, 4 feet in diameter (~ 1.2 m), weighing 235 tons, which provided protection from external X-ray and gamma radiation.

2. ABOUT THE "MIKE" EXPERIMENT

The Mike test was conducted on November 1, 1952 at Eniwetak Atoll. The device consisted of a primary charge TX-5, previously repeatedly tested, and a thermonuclear cylindrical module "Sausage" with liquid deuterium, located in a housing, inside which X-ray radiation was transferred from the primary charge to the thermonuclear module /4/.

The steel body of the device was lined with a layer of lead, to which was attached a layer of polyethylene several centimeters thick. This layer of plastic created plasma pressure during the implosion.

The "Sausage" consisted of a triple steel vessel. The inner vessel contained liquid deuterium. Between its walls and the middle vessel there was a vacuum that prevented heat transfer. Between the middle and outer vessels there was also a vacuum and a protective copper screen cooled with liquid nitrogen.

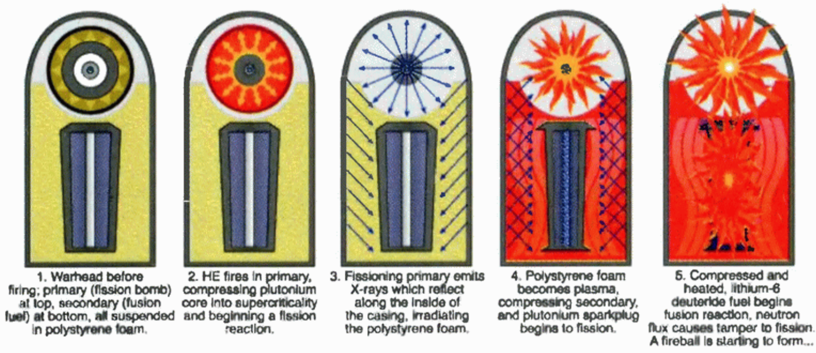
(also liquid).

The outer casing of the device was made of steel and was very thick (about 1 foot) in order to ensure maximum containment of the pressure created by the X-ray radiation. Its internal diameter was about 60 inches (~ 1.5 m). A very wide channel for transmitting radiation along the fusion module ensured that the temperature gradient was minimized and unexpected losses were less likely. The significant volume of the device was also due to the low density of liquid deuterium and the need for a thermal cooling system.

The primary source of the TX-5 was an experimental version of the implosion system, which was adopted as the Mk-5 charge. The TX-5 charge used different types of central parts, which made it possible to provide different levels of energy release. The maximum known energy release of this charge was 47 kg and was realized in the "Easy" test on April 20, 1951. The smaller mass of this charge, compared to others, made it possible to increase the temperature, improve the yield of X-ray radiation from the primary source, and thereby increase the efficiency of the radiation implosion process . If the Mike experiment used the same TX-5 configuration as in the Easy experiment, then the ratio of the energy release of the fusion module to the energy release of the primary source in the Mike experiment was 200:1.

For the Mike device, three types of thermonuclear fuel were considered: liquid deuterium, ammonium deuteride (ND_3) and lithium deuteride.

The reasons why liquid deuterium was chosen were determined by two factors: the greater simplicity of physics for analyzing the problem and intensive study over the previous ten years of fusion fuel based on pure deuterium. The desirability of using Li-6 deuteride as a thermonuclear fuel was known, but by November 1952 it was not possible to produce sufficient quantities of it.



US two-stage charge, built according to the Teller-Ulam scheme /16/.

The energy release due to fission reactions was ~77% in the Mike test. The total energy release due to thermonuclear reactions in the experiment was 2.4 Mt, which corresponds to the complete burnup of 41.6 kg of deuterium in the case of the decisive contribution of DD and DT reactions. The total energy release due to the fission reaction corresponds to the complete burnup of 465 kg of uranium.

The first large-scale design calculations for the Mike device began at LANL in March 1952 on the MANIAC computer. Research into the operation of a thermonuclear test device was divided into successive stages:

• explosion of the primary nuclear charge;

• transfer of X-ray radiation in the device;

• radiation implosion of a module with deuterium fuel and initiator;

• thermonuclear combustion of deuterium fuel;

• the process of fission of natural uranium in the shell surrounding thermonuclear fuel.

For 6 months, the main efforts of the developers were aimed at determining the degree of compression of the thermonuclear unit. Calculations showed that to obtain the required level of thermonuclear combustion, a high degree of compression is required. However, regardless of the test results, it was expected that important information would be obtained about the transfer of X-ray radiation from the primary charge to the crimped thermonuclear module. Data were also to be obtained on the fission characteristics of large quantities of U-238.

At this time, two different approaches to developing thermonuclear charges were considered. The simplest approach involved testing the system as a whole and obtaining the results of this test. The second approach involved testing individual subsystems that make up the device. The first approach, being more complex and risky, achieved the goal directly, but did not show clearly enough why the device worked or failed. Testing subsystems was argued that, although it was a longer approach, it was more informative and consistent with scientific methodology. The first approach was implemented in the Mike experiment.

3. ON THE STATE OF WORK ON RDS-BT AT THE BEGINNING OF 1951

(from materials of NTS PSU, February 1951)

“The work carried out in 1950 revealed a much greater complexity than expected in the theoretical consideration of the process in the “pipe.” New physical factors have been identified: the transfer of part of the reaction energy to electrons in the process of slowing down the primary reaction products; long range and noticeable probability of reaction of deuterons that received energy upon impact with a 14-MeV neutron; the leading role of energy transfer by fast particles (14-MeV neutrons and protons), which can lead to the propagation of the reaction without the formation of a shock wave in deuterium.

Calculations of the regime's capabilities, which Landau will complete by 07/01/1951, will be approximate; It may turn out that the calculation results will not make it possible to draw a definite conclusion about the possibility or impossibility of burning pure deuterium.

The design study showed great technical difficulties associated with the implementation of the actual design of the product (use of hydrogen temperatures, creation of a durable structure with extremely thin walls).

The feasibility of the design depends largely on the results of calculations, which should establish the maximum permissible wall thickness and other physical requirements for the structure.

Theoretical calculations are based on experimental data, and mainly data published in the open foreign press are used. To determine some missing values,

It is necessary to carry out experimental work to verify and clarify the published data.

In accordance with the attached thematic program, it is necessary to study, in particular, secondary processes (T + D, He_3 + D) in the high-energy region and the ranges of fast protons and neutrons produced in these processes.

To fully resolve the issue of creating RDS-6t, it is necessary, along with establishing the conditions for the propagation of the reaction in deuterium, to find a way to initiate the reaction in deuterium using the explosion of an article with a heavy substance and an intermediate detonator from a mixture of deuterium and tritium.

If the question of the existence of the regime remains unresolved, the initiation research, as well as the design work on the “pipe”, is associated with a certain technical risk due to the fact that a certain negative answer to the regime will devalue the work done. The Council considers it advisable to take such a technical risk, since if the issue of the regime is resolved favorably, an early initiation study will shorten the time frame for creating the RDS-6t. If the result of theoretical calculations on the regime is uncertain and the need for an experimental solution to the problem will also require the development of initiation. Initiation calculations should give an approximate estimate of the required amount of heavy fuel and tritium.

Bearing in mind the fundamental possibility, with a favorable result, of using the natural isotope of deuterium in RDS-6t, to significantly strengthen the work on creating RDS-6t.

Due to the great importance of the problem of using deuterium, the Council considers it necessary to intensify work on the creation of RDS-6t and for this purpose proposes the following <...>: "

From the decision of NTS PGU on scientific and technical issues of development of RDS-6t:

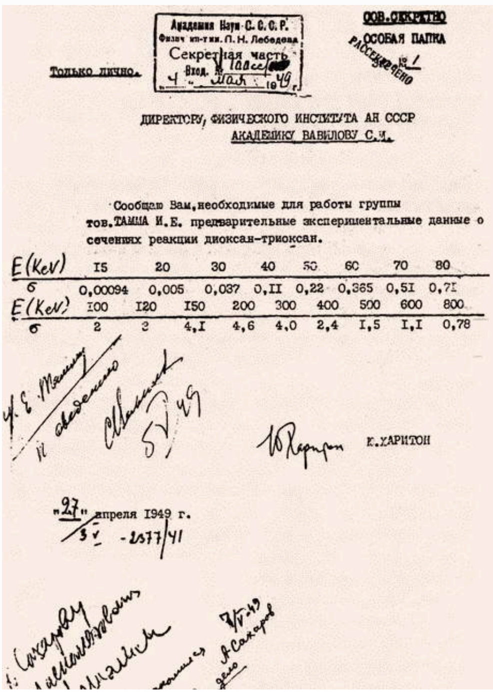
"1. Approve the plan for theoretical work of KB-11 on the “pipe”.

2. Approve the thematic list of works on nuclear measurements required for RDS-6t.

Suggest to KB-11 (responsible - Yu.B. Khariton, with the participation of Landau, Meshcheryakov and Zeldovich) to clarify the order, timing and required accuracy of measurements for individual works and to submit a nuclear work plan on the RDS-6t problem by 03/31/1951.

5. Consider it necessary to create a second group of theoretical physicists, entrusting it with the development of the RDS-6t theory in parallel with Landau’s group. It is considered necessary to put Fok and Kolmogorov at the head of the group, and to involve Ambartsumyan as an expert consultant.

6. Convene a meeting of the Council at the end of February with a report from Landau with the participation of Blokhintsev, Bogolyubov, Vladimirsky, Pomeranchuk, Khristianovich. Invite Landau to submit a report in writing by 02/15/1951.”



Только лично.

Академия Наук С.С.С.Р.
Физич. ин-т им. П. Н. Лебедева
Секретная часть
Вход. № ...
4 мая 1949 г.

СОВ.СЕКРЕТНО
ОСОБАЯ ПАПКА
РАССЕКРЕЧЕНО

ДИРЕКТОРУ ФИЗИЧЕСКОГО ИНСТИТУТА АН СССР
АКАДЕМИКУ ВАВИЛОВУ С.И.

Сообщаю Вам, необходимые для работы группы тов. ТАММА И.Е. предварительные экспериментальные данные о сечениях реакции диоксан-триоксан.

E (KeV)	I5	20	30	40	50	60	70	80	
σ	0,00094	0,005	0,037	0,II	0,22	0,365	0,5I	0,7I	
E (KeV)	I00	I20	I50	200	300	400	500	600	800
σ	2	3	4,I	4,6	4,0	2,4	I,5	I,I	0,78

Ю.ХАРИТОН

"27" апреля 1949 г.

4. FROM THE NUCLEAR PHYSICAL RESEARCH PROGRAM FOR THE CREATION OF THE FIRST THERMONUCLEAR CHARGES

Below are the directions of a number of nuclear physics research related to the development of RDS-6t.

1. Determination of effective cross sections for the reaction $D^2 + D^2$ in the energy range from 30 keV to 1 MeV.

Performers: GTLAN USSR - Meshcheryakov M. G., Davidenko V. A., Kucher A. M.

2. Determination of effective cross sections for the reactions $He^3 + D^2$ and $H^3 + D^2$ in the energy range from 30 keV to 1.6 MeV.

Performers: UPTI - Walter A.K., Klyucharev P.A., Gumenyuk.

3. Measurement of effective cross sections for the reactions $H^3 + H^3$ and $He^3 + H^3$ in the energy range from 30 keV to 1.6 MeV.

Performers: UPTI - Walter A.K., Klyucharev P.A.

4. Determination of effective cross sections for the reactions $D^2 + D^2$ and $He^3 + D^2$ in the energy range from 1 MeV to 3 MeV.

Performers: Institute of Physical Problems of the USSR Academy of Sciences - A.P. Aleksandrov. and Gokhberg B.M.

5. Study of the diffusion of neutrons with energies of 2.5 and 14 MeV in liquid deuterium.

Performers: Institute of Physical Problems of the USSR Academy of Sciences - A.P. Aleksandrov. and Gokhberg B.M.

6. Measurement of effective cross sections for the reaction $D^2 + D^2$ and the angular distribution of the products of this reaction in the energy range 1-10 MeV.

Performers: Leningrad Institute of Physics and Technology of the USSR Academy of Sciences - Komar A.P. and Alkhazov D.G.

7. Study of deuteron scattering in deuterium in the energy range from 1 to 10 MeV.

Performers: Leningrad Institute of Physics and Technology of the USSR Academy of Sciences - Komar A.P. and Alkhazov D.G.

8. Determination of effective cross sections for the $He^3 + D^2$ reaction and measurement of the angular distribution of the products of this reaction in the energy range from 1 to 5 MeV.

Performers: Institute of Chemical Physics - Semenov N.N., Kondratyev V.N. and Kovalsky A.A., Laboratory of Measuring Instruments - Nemenov L.M. and Chubakov A.A.

9. Determination of effective cross sections for the $He^3 + D^2$ reaction and measurement of the angular distribution of the products of this reaction in the energy range from 0.8 to 5 MeV.

Performers: Institute of Chemical Physics - Semenov N.N., Kondratyev V.N. and Kovalsky A.A., Laboratory of Measuring Instruments - Nemenov L.M. and Chubakov A.A.

10. Study of the scattering of protons with energies from 1 to 8 MeV in deuterium.

Performers: Institute of Chemical Physics - Semenov N.N., Kondratyev V.N. and Kovalsky A.A., Laboratory of Measuring Instruments - Nemenov L.M. and Chubakov A.A.

11. Study of deuteron scattering in H^3 and He^3 in the energy range 1-5 MeV.

Performers: Institute of Chemical Physics - Semenov N.N., Kondratyev V.N. and Kovalsky A.A., Laboratory of Measuring Instruments - Nemenov L.M. and Chubakov A.A.

The program was signed by Yu.B. Khariton.

***

Below are the directions of a number of nuclear physics research related to the development of RDS-6s.

1. Refinement of the cross section for the D+T reaction in the energy range from 30 to 200 keV. Required measurement accuracy ± 10%. The work should be carried out at FIAN (I.M. Frank, Barit, Balabanov) and at UPTI (Walter, Klyucharyov). Completion of work - 12/31/1951.

2. Study of the distribution of neutrons, the number of fissions and the number of captures in systems of U^{238}, Li^7, Li^6 and D. The work should be carried out at KB-11 (Zysin), at the Lebedev Physical Institute (Frank, Barit, Groshev, Balabanov). Completion of work - 12/31/1951.

3. Measurement of the neutron capture cross section of Li^6 and Li^7 in the energy range from 50 to 200 keV. The required measurement accuracy is 30%. The work should be carried out at UPTI (Walter, Taranov). Completion of work - 05/01/1951.

4. Measurement of the neutron capture cross section of U^{238} in the energy range from 50 to 200 keV. The required measurement accuracy is 20%. The work will be carried out jointly by UPTI (Walter, Taranov) and KB-11 (Flerov, Dmitriev, Zamyatnin). Completion of work - 07/01/1951.

7. Study of the efficiency of 14-MeV neutrons when passing through Li^7 D and Li^6 D layers. Experiments with Li^7 D should be completed by 03/01/1951.

Experiments with Li6D will be completed in a month after receiving the required quantities of material. The work will be carried out in KB-11 by Flerov and Zysin.

8. Study of changes in the spectrum of 14-MeV neutrons when they pass through layers of different thicknesses from Li^7 D, Li^6 D and U^{238}.

9. Determination of the U238 fission cross section in the energy range from 1 to 14 MeV with an accuracy of 20%. The work will be carried out using the LIPAN cyclotron. Performers: Nemenov, Kalinin, Flerov, Kutikov, Berezin.

The work will be completed two months after the deuteron beam is removed from the cyclotron to a distance of 8 m.

10. Study of the splitting of Li^{7} and Li^{6} under the influence of 14-MeV neutrons. The work will be carried out in LIPAN by Yu.L. Sokolov. and Flerov. The deadline for work is 07/01/1951.

11. Determination of the cross section for the splitting of Li^{6} by neutrons with energies from 1 to 14 MeV with an accuracy of ± 20. The work will be carried out at LIPAN by Nemenov, Kalinin, Sokolov, Kutikov, Berezin.

The work will be completed 3 months after the deuteron beam is removed from the cyclotron to a distance of 8 meters.

12. Selection of radioactive indicators for 14-MeV neutrons. IHF and RIAN - Old Man, Kondratiev, Neumann, Talrose. Completion of work - 12/31/1951.

13. Measurement of the transport cross section of 2-, 5- and 14-MeV neutrons in Li^{6} - Kondratiev, Buben. Completion of work - 04/01/1951.

14. Study of neutron capture by U238n Th232 in the energy range from 5 to 100 keV with an accuracy of 30%. UPTI - Walter, Taranov. Completion of work - 07/01/1951.

15. Measurement of the fission cross section of U^{233}, U^{235}, U^{239} by neutrons with energies from 5 to 100 keV with an accuracy of 30%. UPTI - Walter, Taranov; TTL - Meshcheryakov, Siksin. Completion of work - 07/01/1951.

16. Study of the fission of U^{239} and Th^{233} by thermal neutrons. Performers and completion date can be determined after a series of discussions.

17. Preparatory work for studying the fission of U^{239} by fast neutrons in KB-11 (Flerov, Dmitriev). Completion of work - 12/31/1951.

The program was signed by Yu.B. Khariton and G.N. Flerov.

5. THE USSR BEGINS TO CONTROL US NUCLEAR TESTS

In a letter from Yu. B. Khariton to L.P. Beria dated June 16, 1950, apparently, for the first time the question of developing acoustic equipment for recording powerful explosions “that will be produced somewhere” is raised. The equipment was designed in 1951 by ICP specialists /24/.

The first studies on the problem of monitoring nuclear explosions in the USSR began in 1951. The “Mike” explosion on Enewetak Atoll was recorded by seismic stations of the USSR.

Based on the proposal of 1952 by A.D. Sakharov and D.A. Frank-Kamenetsky in Laboratory No. 2 of the Academy of Sciences under the direction of I.K. Kikoin, work began on creating methods for recording radioactive explosion products.

Under the leadership of I.V. Kurchatov in 1952-1954. radiochemical methods were developed for isolating radioactive explosion products from air filters, plate samples and soil samples; Highly sensitive installations were created to measure radiation spectra.

Since the United States announced in advance that powerful explosions would be carried out on the Enewetak and Bikini atolls in the Pacific Ocean, the USSR carried out large-scale work to register them using various methods on the territory of the USSR and China.

More than 50 ships of various classes were sent to the testing area, which were located outside the boundaries of the restricted zone declared by the United States.

As N.M. showed Emanuel, this work turned out to be extremely useful in estimating the amount of fissile material in the bomb of the American explosion on March 1, 1954 at Bikini (Bravo experiment) / 1, p. 386/ (it was already known from the open press that the power of “Bravo” was 14 Mt, and the power of the “Mike” explosion was 5 Mt/1, p. 387/).

The main conclusion: “The hydrogen bomb exploded on March 1, 1954 at Bikini contained a large amount of fissile material, exceeding the atomic charge required to initiate a thermonuclear reaction” /1, p. 391/.

On March 4, 1954, the leadership of the Ministry of Defense decided to create a Service for Special Control over Testing of Nuclear Weapons Abroad in the GRU General Staff.

As a result, a series of US nuclear explosions in the Pacific Ocean from February 18 to March 13, 1954 was recorded by acoustic, aerosol and seismic means.

Letter from Yu.B. Khariton and Ya.B. Zeldovich V.A. Malyshev with proposals for conducting physical measurements during the upcoming tests of the American hydrogen bomb at Bikini

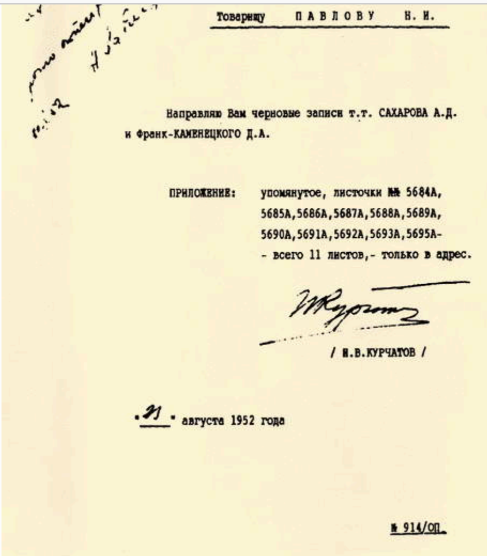
January 12, 1954

“In connection with the upcoming explosion of a hydrogen bomb on Bikini in the spring, it seems very important, along with radiochemical measurements, to try to obtain data on the moment of the explosion and its power through acoustic measurements.

It is desirable that the relevant work be included in the plan of LIP AN (t. Kikoin I.K.). At the same time, due to the complexity of issues of sound propagation in the atmosphere over long distances, it is advisable to involve the best Soviet acousticians: vol. Andreeva N.N., Brekhovskikh, Konstantinova B.P. and Sedova L.I.

It would be worth considering the possibility of using whaling fleet ships or other vessels for observations, along with the nearest bases on the ground.”


СОВ.СЕКРЕТНО
ОСОБАЯ ПАПКА
Экз.№ 1



Товарищу ПАВЛОВУ Н. И.

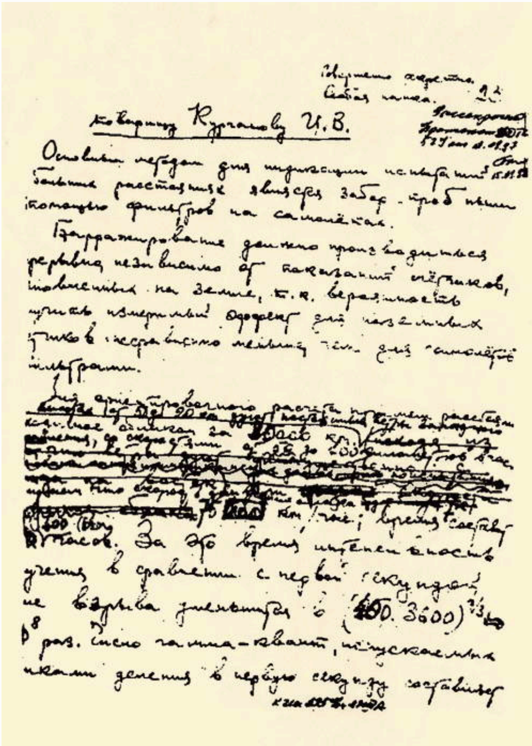
Направляю Вам черновые записи т.т. САХАРОВА А.Д. и Франк-КАМЕНЕЦКОГО Д.А.

ПРИЛОЖЕНИЕ: упомянутое, листочки №№ 5684А, 5685А, 5686А, 5687А, 5688А, 5689А, 5690А, 5691А, 5692А, 5693А, 5695А- – всего 11 листов,- только в адрес.

/ И.В.КУРЧАТОВ /

"21" августа 1952 года

№ 914/оп.



Совершенно секретно. Особая папка.

Товарищу Курчатову И.В.

Основным методом для индикации испытаний на больших расстояниях является забор проб пыли с помощью фильтров на самолётах.

Барражирование должно производиться регулярно независимо от показаний счётчиков, помещённых на Земле, т.к. вероятность уловить измеримый эффект для наземных счётчиков несравненно меньше, чем для самолётных фильтров.

[illegible] часов. За это время интенсивность упадёт в сравнении с первой секундой после взрыва приблизительно в $(400 \cdot 3600)^{1.3} \approx 10^8$ раз. Число гамма-квантов, испускаемых ядрами деления в первую секунду составляет [illegible]

Aerosol Method Documents

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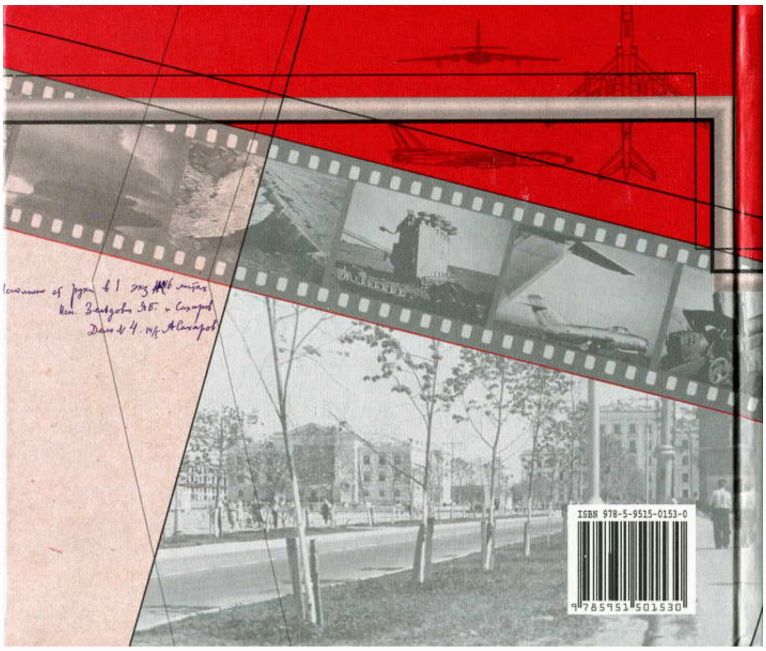
Modern Sarov



Notes

1

(back)

2

This means uranium-235.

(back)

3

This refers to the test of the Mike thermonuclear device conducted on November 1, 1952.

(back)

4

This material, received by KB-11 from the PGU secretariat under the Council of Ministers of the USSR as a TASS report, was returned to the head of the secretariat V.S. Kuznetsov with a transmittal note dated February 27, 1953 (ref. No. 74/3c), signed by K.I. Shchelkin.

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